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Portable dual-trace oscilloscope

PM 3260(E)

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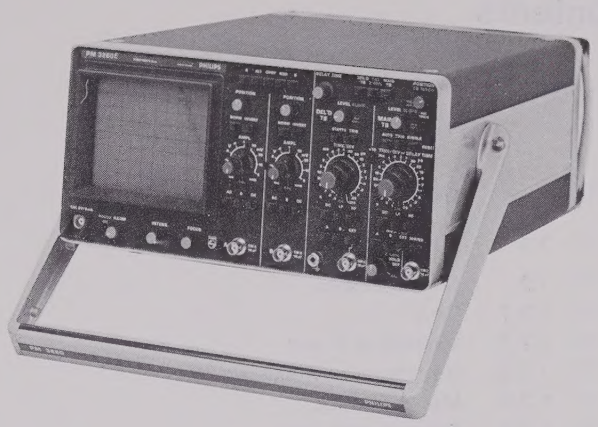

Instruction manual

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Tragbarer Zweistrahl-Oszillograf
Oscilloscope double trace portatif

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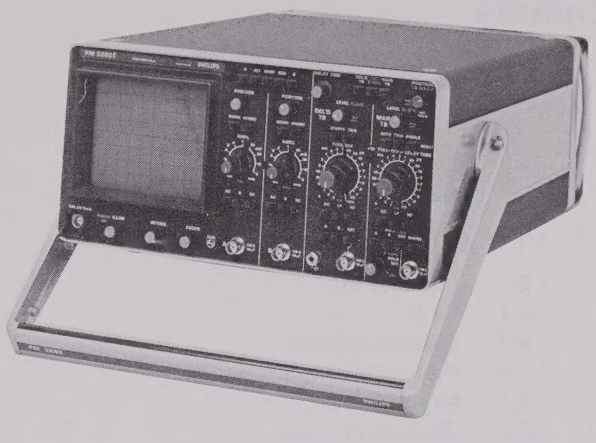

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PRINTED IN THE NETHERLANDS

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Operating manual

1. General information

1.1. INTRODUCTION

The PM 3260 Portable oscilloscope enables the measurement of signals at a high sensitivity (5 mV/DIV) over a large bandwidth (120 MHz). The oscilloscope is provided with many thin-film circuits which guarantee a very stable operation and reduce the number of adjusting points.

There is a wide choice of display possibilities, such as one channel, two channels alternately or chopped, two channels added, with normal and inverted positions for both input signals, and a main and delayed time-base.

The PM 3260 oscilloscope features a tapless power supply with low dissipation. This power supply works on any a.c. voltage between 90 V and 264 V, thus obviating the need of adjusting the instrument to the local mains voltage.

All these features make the oscilloscope suitable for a wide variety of applications.

The PM 3260E oscilloscope is a similar instrument, but without calibrated delay-time multiplier knob and probe-power supply.

Fig. 1.1. Portable dual-trace oscilloscope PM 3260

1.2. CHARACTERISTICS

This specification is valid after the instrument has warmed up for 15 minutes. Properties expressed in numerical values with tolerances stated, are guaranteed by the manufacturer. Numerical values without tolerances are typical and represent the characteristics of an average instrument.

Designation		Specification	Additional information
1.2.1.	C.R.T.		
	Type	PHILIPS D14-240	Rectangular tube face, domed mesh type, post-accelerator, metal-backed phosphor
	Measuring area	80 mm x 100 mm	
	Screen type	P31 (GH) phosphor	P7 (GM) phosphor optional
	Photographic writing speed	> 1500 cm/μs	Measured with Steinheil Oscillophot M5 camera. Aperture: 1:1,2 Object to image ratio: 1:0,5 Film: Polaroid 410 (10000 ASA) No pre-fogging Phosphor type P31 (GH)
	Total acceleration voltage	20 kV	
	Graticule	Internal	Continuously variable illumination
	Engravings	Centimetre divisions with sub-divisions of 2 mm along the central axes. Dotted lines indicate 10 % and 90 % of measuring lattice for measurement of rise time	
1.2.2.	VERTICAL OR Y AXIS		
1.2.2.1.	*Response*		
	Frequency range	d.c. ... 120 MHz 10 Hz ... 120 MHz	−3 dB bandwidth d.c. coupled −3 dB bandwidth a.c. coupled
	Rise time	≈ 3 ns	
	Pulse aberrations	±3 % (4 % peak-to-peak)	
1.2.2.2.	*Deflection coefficients*	5 mV/DIV ... 2 V/DIV	Nine calibrated positions in 1-2-5 sequence. Uncalibrated continuous control 1 : ⩾ 2,5
1.2.2.3.	*Error limit*	±3 %	
1.2.2.4.	*Max. permissible input voltage*	±400 V 800 $V_{p\text{-}p}$ a.c.	d.c. + a.c. peak. Up to 20 mV position of input attenuator derating at frequencies over 500 kHz. See Fig. 1.2.
1.2.2.5.	*Instability of the spot position*		
	Trace jump	< 0,3 Div	When switching between any of the attenuator positions
	Trace jump	< 0,3 Div	When switching the NORM/INVERT switch
	Trace shift	< 0,3 Div	When rotating the continuous attenuator
	Trace shift	< 1 Div	When switching to the ADDED position
	Temperature drift	< 60 μV/°C	Typical value

Designation	Specification	Additional information
1.2.2.6. Maximum deflection		
Undistorted	24 divisions	
Shift range	16 divisions	8 divisions each in topward and downward direction reckoned from the central horizontal graticule line
1.2.2.7. Input impedance	1 MOhm//15 pF	
1.2.2.8. Input RC time	⩾ 17 ms	Coupling switch to AC
1.2.2.9. Visible signal delay	Approximately 30 ns	
1.2.2.10. Display modes	Channel + or −A only Channel + or −B only Channels ±A and ±B chopped Channels ±A and ±B alternate Channels ±A and ±B added	
1.2.2.11. Chopper frequency	≈ 1 MHz	
1.2.2.12. Cross-talk between channels	1 : 500	2 divisions of signal amplitude at 50 MHz on one channel set to .2 V/DIV. Cross-talk is measured on other channel set to 20 mV/DIV
1.2.2.13. Common-mode rejection factor	100 at 100 kHz 100 at 2 MHz 20 at 50 MHz	Measured with +A and −B added; max. common mode signal 8 divisions
1.2.3. HORIZONTAL OR X AXIS		
1.2.3.1. Display modes	– Main time base – Main time base intensified by delayed time base – Delayed time base – XY Operation	X deflection by: – Channel A signal – Channel B signal – Signal applied to EXT connector of main time base – Mains frequency
1.2.4. MAIN TIME BASE		
1.2.4.1. Operation	Triggered Automatic Single shot	Possibility of automatic free-running in the absence of triggering signals
1.2.4.2. Time coefficients	1 s/Div ... 50 ns/Div	Twenty-three calibrated positions in 1-2-5 sequence. Uncalibrated continuous control 1 : ⩾ 2,5 between the steps
1.2.4.3. Coefficient error	±2 % ±3 %	+20 °C ... +30 °C +5 °C ... +40 °C Sweep accuracy over any two divisions of 10 DIV sweep is ±5 %. Exclude the first and last DIV at the 5 ns and 10 ns magnified sweep rates.

Designation	Specification	Additional information
1.2.4.4. Expansion		
Magnification	10x	Switched, calibrated
Additional error	±1 %	First and last 50 ns of 5 ns, 10 ns and 20 ns magnified sweep rates excluded.
Max. effective time coefficient	5 ns/Div	
1.2.4.5. Variable hold-off time	The sweep hold-off time can be increased by approx. a factor of 10	
1.2.5. DELAYED TIME BASE		
1.2.5.1. Operation	Delayed time base starts at option either immediately after the delay time, or upon arrival of the first trigger pulse after the delay time	
1.2.5.2. Time coefficient	0,5 s/DIV ... 50 ns/DIV	Twenty-two calibrated positions in 1-2-5 sequence. Uncalibrated continuous control 1 : ⩾ 2,5 between the steps
1.2.5.3. Coefficient error	±2 % ±3 %	+20 °C ... +30 °C +5 °C ... +40 °C Sweep accuracy over any two divisions of 10 DIV sweep is ±5 %. Exclude the first and last DIV at the 5 ns and 10 ns magnified sweep rates.
1.2.5.4. Delay time	Continuously variable between 0x and 10x the time coefficient of the main time base	Calibrated in the standard model PM 3260. Range delay-time multiplier 0,00 - 9,99. Incremental accuracy 0,5 %; typical 0,2 %. Not calibrated in the PM 3260E model.
1.2.5.5. Delay-time jitter	< 1 : 20 000	Typical value 1 : 30 000
1.2.6. X DEFLECTION		
X Deflection via channel Y_A		
1.2.6.1. Deflection coefficient	5 mV/DIV ... 2 V/DIV	Uncalibrated continuous control 3:1 via X AMPL potentiometer
1.2.6.2. Coefficient error	±5 %	
1.2.6.3. Bandwidth	0 ... 2 MHz	–3 dB bandwidth over 8 DIV
1.2.6.4. Input impedance	1 MOhm//15 pF	
1.2.6.5. Phase difference	3° at 100 kHz	
External X deflection via EXT socket		
1.2.6.6. Deflection coefficient	300 mV/DIV	One calibrated position. Uncalibrated continuous control ⩾ 3:1.
1.2.6.7. Bandwidth	0 ... 2 MHz	–3 dB bandwidth over 8 DIV

Designation	Specification	Additional information
1.2.6.8. Input characteristics	Identical to Y channels	
1.2.6.9. Phase difference	3° at 100 kHz	

X Deflection with internal voltage at mains frequency

The deflection depends on the mains voltage and has been factory-adjusted to 8 DIV at a mains voltage of 220 V.

1.2.7. TRIGGERING OF THE MAIN TIME BASE

1.2.7.1. Source	Internal from channel A Internal from channel B Internal from mains External source	
1.2.7.2. Mode	Automatic	Automatic free-run of the time-base generator approx. 100 ms after disappearance of the trigger signal.
	Manual level Single sweep	
1.2.7.3. Slope	+ or –	
1.2.7.4. Sensitivity	Internal ⩽ 0,5 DIV External ⩽ 150 mV	Typical sensitivity as a function of frequency, see Fig. 1.3.
1.2.7.5. Filter bandwidth	DC: 0 - 120 MHz	Flat response, both internal and external
	LF: 0 - 30 kHz	–3 dB, internal
	LF: 10 Hz - 30 kHz	–3 dB, external
	HF: 30 kHz - 120 MHz	–3 dB, both internal and external
1.2.7.6. Level range	24 DIV	at internal trigg.
	–3,6 V to +3,6 V	at external trigg.
1.2.7.7. Input characteristics	Identical to Y channels	

1.2.8. TRIGGERING OF THE DELAYED TIME BASE

1.2.8.1. Source	Internal from channel A Internal from channel B External	

Other characteristics are identical to TRIGGERING OF THE MAIN TIME BASE.

1.2.9. CALIBRATION UNIT

1.2.9.1. Output voltage	3 V_{p-p}	
1.2.9.2. Output current	6 mA	
1.2.9.3. Error limit	±1 %	Both voltage and current
1.2.9.4. Frequency	2 kHz < 2 %	
1.2.9.5. Protection	The output is protected against continuous short-circuits	

Designation	Specification	Additional information
1.2.10. POWER SUPPLY		
1.2.10.1. Mains voltages	Any voltage between 100 and 240 V ±10 % in one range	
1.2.10.2. Mains frequency	46 to 440 Hz	
1.2.10.3. Probe power	+ and −24 V	Not provided on PM 3260E model
1.2.10.4. Power consumption	45 W	
1.2.11. ENVIRONMENTAL CAPABILITIES		
1.2.11.1. Ambient temperature	+5 °C ... +40 °C −10 °C ... +55 °C −40 °C ... +70 °C	Rated range of use Limit range of operation Storage and transport conditions
1.2.11.2. Altitude	5 000 m 15 000 m	Operating Not operating
1.2.11.3. Humidity	The instrument meets the requirements of the IEC 50 B (CO) 142 recommendations	
1.2.11.4. Shock	The instrument meets the requirements of the IEC 68 Eb recommendations	
1.2.11.5. Vibration	The instrument meets the requirements of the IEC 68 F recommendations	
1.2.11.6. Recovery time	15 minutes for normal operation	Coming from −10 °C and going to +20 °C at 60 % relative humidity
1.2.12. MECHANICAL DATA		
1.2.12.1. Dimensions	Length 410 mm (16 1/4") Width 316 mm (12 1/4") Height 154 mm (6 1/8")	Excl. controls, cover and feet
1.2.12.2. Weight	9,3 kg (20.5 lbs)	

1.2.13. ACCESSORIES

1.2.13.1. Accessories delivered with the instrument

Two contrast filters
Front cover with storage space
Collapsible viewing hood PM 9366
Banana - BNC adapter PM 9051
CAL terminal - BNC adapter
Manual

1.2.13.2. Optional accessories

PM 9335	Passive 1:1 probe
PM 9351	Passive 10:1 probe
PM 9358	Passive 100:1 high-voltage probe
PM 9347*)	Active t.v. probe
PM 9352*)	Active microminiature probe
PM 9353*)	Active F.E.T. probe
PM 8960	Rack-mounting adapter
PM 8971	Camera flange
PM 9380	Oscilloscope camera
	Oscilloscope camera range Steinheil Oscillophot

*) Auxiliary Probe Power Supply PM 9346 is necessary if these probes are to be used with the PM 3260E model.

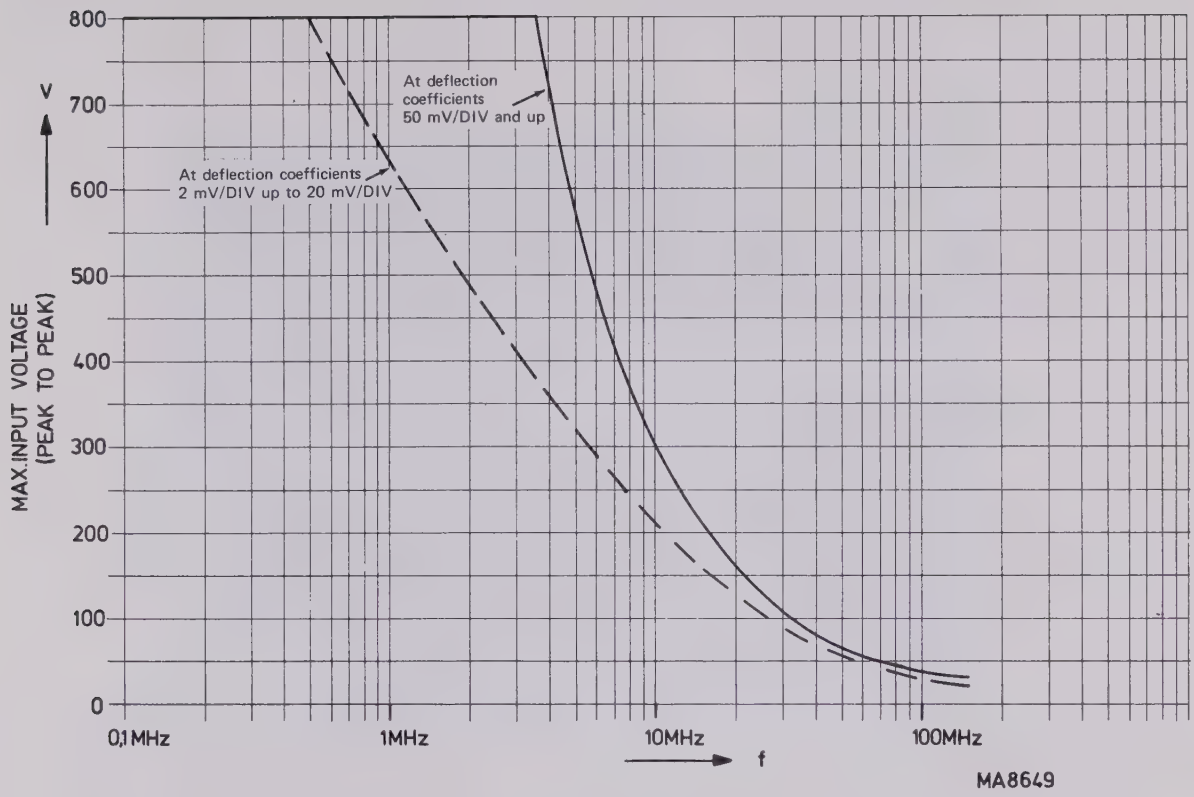

Fig. 1.2. Derating of the maximum permissible input voltage as a function of frequency

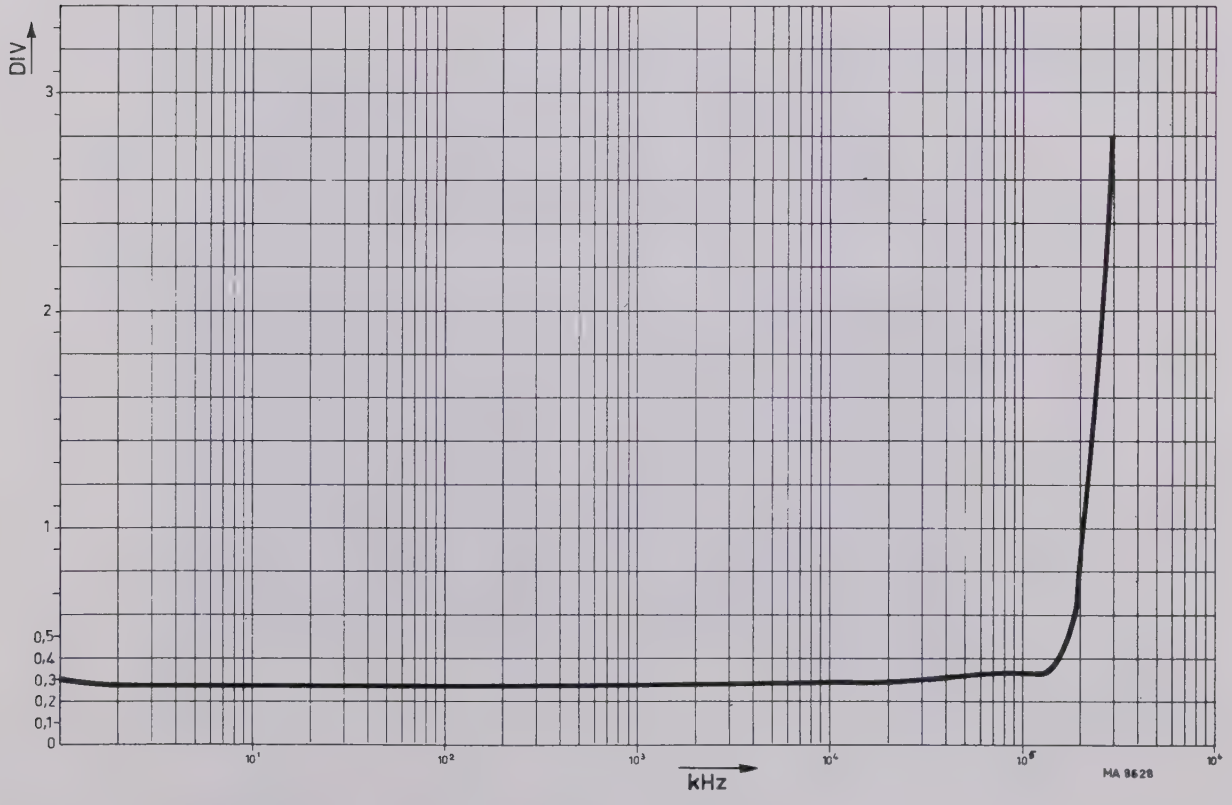

Fig. 1.3. Typical trigger sensitivity of channel A as a function of frequency

Fig. 2.1. Removing front cover

Fig. 2.2. Rear view of the instrument

2. Directions for use

2.1. INSTALLATION

2.1.1. Removing and fitting the front cover

Removing: – Turn the knob in the centre of the cover a quarter of a turn anti-clockwise to position UNLOCKED.
– Take the cover off.

Fitting: – Turn the knob to the UNLOCKED position.
– Fit the cover over the front of the oscilloscope.
– Press the knob and turn it a quarter of a turn clockwise to the LOCKED position.

Remark: The handle can be rotated if the push-buttons on its bearings are depressed.

Warning: This instrument generates high voltages and should not be operated with the cabinet plates removed. The mains plug must be removed before attempting any maintenance work, and any relevant high-voltage points discharged.

2.1.2. Mains adjustment and fuse

The ability of the instrument to operate at any mains voltage between 90 and 264 Va.c., obivates the need of adaptation to the local mains voltage.
The fuse holder which is mounted on the rear panel carries a 2 A delayed action fuse. The use of repaired fuses and the short-circuiting of fuse holders is prohibited.

2.1.3. Earthing

In the interests of safety, the oscilloscope must be connected to earth via the rear earthing terminal (identified by the symbol ⏚) or via the mains lead, provided that the supply socket is equipped with an earth connection. Care must be taken that the earth line to the oscilloscope is not interrupted due to the use of an extension lead or device which is not fitted with an earth conductor.

2.1.4. Switching on

The POWER switch is incorporated in the graticule ILLUMination control on the front panel, immediately below the screen bezel. The oscilloscope must never be switched on whilst any circuit board or block has been removed.
Never remove a circuit board or block until at least one minute after the oscilloscope has been switched off.

2.2. OPERATING INSTRUCTIONS

Before switching on, ensure that the oscilloscope has been correctly installed in accordance with section 2.1. INSTALLATION and that the precautions outlined have been observed.

2.2.1. Controls and sockets (Fig. 2.3.)

2.2.1.1. Vertical channels

A/ALT/CHOP/ADD/B	Display-mode controls; 5-way push-button switch.
A depressed	Vertical deflection is achieved by the signal connected to the input of channel A.
ALT depressed	The display is switched over from one vertical channel to the other at the end of every cycle of the time-base signal.
CHOP depressed	The display is switched over from one vertical channel to the other at a fixed frequency.
ADD depressed	Vertical deflection is achieved by the sum signal of channels A and B.
B depressed	Vertical deflection is achieved by the signal connected to the input of channel B. If no push-button is depressed, the instrument operates in the ALT mode.
POSITION	Continuously variable control giving vertical shift of the display.
NORM/INVERT	2-Way push-button switch for the inversion of the signal polarity. No push-button depressed has the same effect as the NORM button depressed.
AMPL.	Step control of the vertical deflection coefficients; 9-way switch.
AMPL./CAL. (blue)	Continuously variable control of the vertical deflection coefficients. In the CAL. position the deflection coefficient is calibrated.
BAL (screw-driver operated)	Continuously variable control of the direct voltage balance of the vertical amplifiers.
GAIN (screw-driver operated)	Continuously variable control of the overall gain of the vertical channels.
AC/0/DC	Signal coupling; 3-way push-button switch.
AC depressed	Coupling via a blocking capacitor
0 depressed	Connection between input circuit and input socket is interrupted and the amplifier input is earthed
DC depressed	Direct coupling No button depressed has the same effect as the AC button depressed.
A 1 MOhm - 15 pF	BNC input socket for channel A
B 1 MOhm - 15 pF	BNC input socket for channel B

2.2.1.2. Horizontal channel

DEL'D TB - EXT. X DEFL - MAIN TB	Horizontal-deflection controls; 3-way push-button switch.
DEL'D TB depressed	The horizontal deflection voltage is supplied by the delayed time-base generator.
EXT. X DEFL depressed	Horizontal deflection is achieved by an external signal applied to the input socket of the horizontal amplifier, by the channel A signal, by the channel B signal or by a mains-frequency signal.

MAIN TB depressed — The horizontal deflection voltage is supplied by the main time-base generator.
A part of the trace is intensified (except in position OFF of the TIME/DIV switch of the delayed time-base generator).
No button depressed has the same effect as the MAIN TB button depressed.

POSITION
TB MAGN — Continuously variable control giving horizontal shift of the display; incorporates a push-pull switch which increases the horizontal deflection coefficient by a factor 10. A pilot lamp labelled x10 lights up when the magnifier is in operation.

X AMPL/HOLD OFF — Continuously variable control of the horizontal deflection coefficients in case of external X deflection.
In case of X deflection by the main time base, this control can be used to increase the sweep hold-off time.

2.2.1.3. Main time-base generator

LEVEL — Continuously variable control to select the level of the triggering signal at which the time-base generator starts.
This control incorporates a push-pull switch which enables choice of triggering on the positive- or negative-going edge of the triggering signal.

NOT TRIG'D — Pilot lamp which lights up when the time-base generator is in waiting position.

AUTO - TRIG - SINGLE — Trigger-mode controls; 3-way push-button switch.

AUTO depressed — The main time-base generator is free-running in the absence of triggering signals.

TRIG depressed — The time-base generator is normally triggered.

SINGLE depressed — After operating the SINGLE button, the time-base generator runs only once upon receipt of a trigger pulse.
If no button is depressed, the instrument operates in the SINGLE mode.

Fig. 2.3. Front view of the instrument

TIME/DIV or DELAY TIME	Time-coefficient control of the main time-base; 23-way rotary switch.
TIME/DIV - CAL (blue)	Continuously variable control of the time coefficient of the main time-base. In the CAL position the time coefficient is calibrated.
DC - LF - HF	Trigger coupling; 3-way push-button switch.
DC	Triggering signals are direct-coupled.
LF	Coupling via low-pass filter for frequencies up to 30 kHz (for external triggering via band-pass filter of 10 Hz - 30 kHz).
HF	Coupling via a high-pass filter for frequencies higher than 30 kHz. No push-button depressed has the same effect as button DC depressed.
TRIG or X DEFL	Trigger source or external X deflection selector; 4-way push-button switch.
A	Internal triggering or X deflection signal derived from channel A.
B	Internal triggering or X deflection signal derived from channel B.
EXT	Triggering on external signal connected to the adjacent 1 MOhm-15 pF socket. When the EXT X DEFL button of the horizontal deflection controls is depressed, this socket is connected to the input of the horizontal amplifier.
MAINS	Triggering or X deflection signal derived from an internal voltage with the mains frequency. No push-button depressed has the same effect as button A depressed.
1 MOhm - 15 pF	BNC socket for external triggering or horizontal deflection.

2.2.1.4. Delayed time-base generator

DELAY TIME MULTIPLIER	Continuously variable control of the delay time, operating together with the TIME/DIV controls of the main time-base generator.
LEVEL SLOPE	Continuously variable control to select the level of the triggering signal at which the delayed time-base generator starts. This control incorporates a push-pull switch which enables choice of triggering on the positive- or negative-going edge of the triggering signal.
STARTS - TRIG	Choice of the starting point of the delayed time-base generator after the delay time; 2-way push-button switch.
STARTS	The delayed time-base generator is started immediately after the delay time.
TRIG	The delayed time-base generator starts after the delay time upon receipt of a trigger pulse. No push-button depressed has the same effect as the STARTS button depressed.
TIME/DIV	Time-coefficient control of the delayed time-base; 23-way rotary switch. Incorporates an OFF position in which the delayed time-base generator is switched off.
TIME/DIV - CAL (blue)	Continuously variable control of the time coefficient of the delayed time-base generator. In the CAL position the time coefficient is calibrated.

DC - LF - HF	Trigger coupling; 3-way push-button switch.
DC	Triggering signals are direct-coupled.
LF	Coupling via low-pass filter for frequencies up to 30 kHz (for external triggering via band-pass filter of 10 Hz to 30 kHz).
HF	Coupling via a high-pass filter for frequencies higher than 30 kHz. No button depressed has the same effect as the DC button depressed.
A - B - EXT	Trigger source control; 3-way push-button switch.
A	Internal triggering signal derived from channel A.
B	Internal triggering signal derived from channel B.
EXT	Triggering on an external signal connected to the adjacent 1 MOhm-15 pF socket.
	No button depressed has the same effect as the A button depressed.
1 MOhm - 15 pF	BNC input socket for external triggering signal.

2.2.1.5. Cathode-ray tube

ILLUM POWER	Continuously variable control of the graticule illumination; incorporates mains switch. Pilot lamp indicates the ON state.
INTENS	Continuously variable control of the trace brilliance.
FOCUS	Continuously variable control of the electron-beam focusing.

2.2.1.6. Miscellaneous

CAL	Output socket on which a square-wave voltage of 3 $V_{p\text{-}p}$ and a current of 6 mA at a frequency of 2 kHz are available. Amplitude accuracy: ±1 %. Frequency accuracy: ±2 %. The output is protected against continuous short-circuits.
PROBE POWER	Power socket for active accessories; supplies +24 V and −24 V.
⏚	Measuring-earth socket

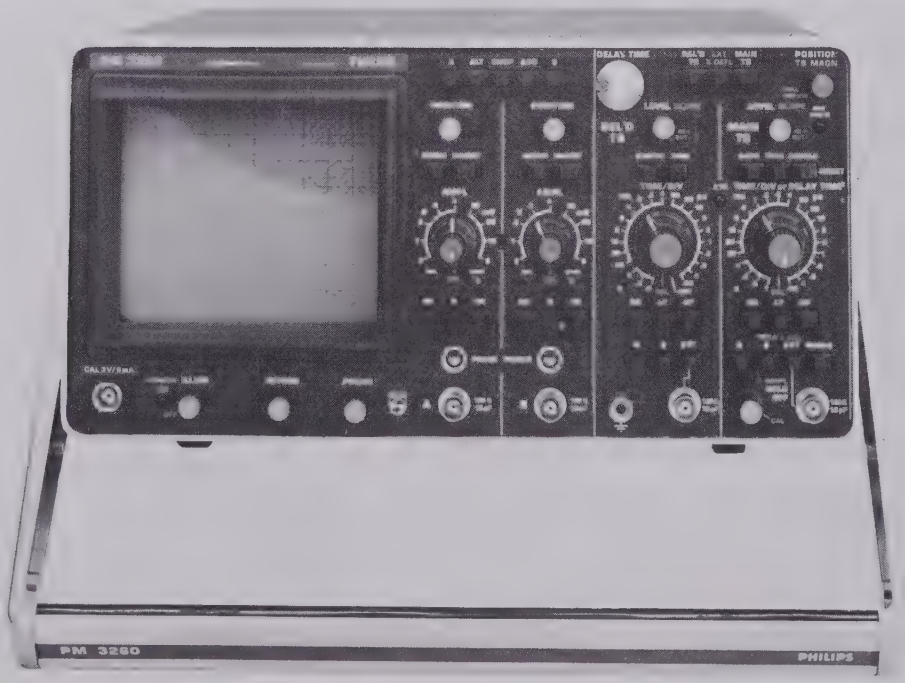

Fig. 2.3. Front view of the instrument

2.2.2. Preliminary settings

As the following settings are identical for both vertical channels, only the procedure for channel A has been indicated.

2.2.2.1. Adjusting the d.c. balance

- Operate push-button A of the display-mode controls.
- Operate push-button AUTO of the trigger-mode controls.
- Operate push-button MAIN TB of the horizontal deflection controls.
- Set the AMPLitude switch to 5 mV and the continuous control to CALibrated.
- Centre the trace with the POSITION controls.
- Set the INTENSity and FOCUS controls for a sharp, well-defined trace.
  The controls not mentioned may occupy any position.
- Check that the trace does not jump when the AMPL switch is switched between the 5 and 10 mV positions.
  If necessary, readjust the BALance control on the front panel immediately below the AMPLitude control.

2.2.2.2. Adjusting the gain

Unless otherwise stated, the controls occupy the same position as in the previous adjusting procedure.
- Set the AC-0-DC switch to DC.
- Set the AMPLitude switch to .5 V and the continuous control to CALibrated.
- Connect the CALibration socket to the A input socket.
- Check that the trace height is exactly 6 divisions.
  If necessary, readjust the GAIN control on the front panel, immediately below the AMPLitude switch.

2.2.3. Inputs A and B and their possibilities

The oscilloscope has been provided with two identical channels, each of which can be used for either YT measurements in combination with one or both time-base generators, or XY measurements in combination with the external horizontal channel.

2.2.3.1. YT Measurements

To display one signal, either of the two vertical channels can be selected by operating either push-button A or push-button B of the display-mode controls.
When push-button ALT or CHOP is depressed, two different signals can be displayed simultaneously. The Y deflection coefficient and the polarity can be selected for each channel individually. When the ALT button is operated, the display is switched over from one channel to the other at the flyback of the time-base signal. Although the ALTERNATE mode can be used at all sweep speeds of the time-base generator, the CHOPPED mode will give a better display quality for long sweep times, because during these long sweep times the alternate display of the two input signals is clearly visible to the eye.

In the CHOPPED mode, the display is switched over from one channel to the other at a fixed frequency.
If push-button ADDED of the display-mode switch is operated, the signal voltages of both vertical channels are added. Depending on the positions of the polarity switches, either the sum or the difference of the input signals is displayed. The ADDED mode also enables differential measurements. With these measurements advantage is taken from the common mode rejection in the ADDED position. When the polarity switches of both channels are set to opposite positions, the common mode parts of the signals on sockets A and B will undergo a very slight amplification only, with respect to the differential mode parts.

2.2.3.2. XY Measurements

If push-buttons EXT X DEFL of the horizontal-deflection controls and A of the TRIG OR X DEFL controls are operated, the time-base generators are switched off. A signal applied to the vertical A channel is then used for horizontal deflection. The AC/0/DC switch and the step attenuator of channel A remain operative. Continuous control of the deflection coefficients is possible with the X DEFL/HOLD OFF control and horizontal trace shift with the X POSITION control.

Vertical channel B may also be used for X deflection.
To this end, the B button of the TRIG OR X DEFL controls is depressed.

It is also possible to use an internal voltage at the mains frequency or a signal applied to the EXT socket at the bottom right-hand side of the front panel for X deflection, after depressing the relevant push-button of the TRIG OR X DEFL controls. In these modes the trace width can be controlled with the X DEFL/HOLD OFF potentiometer.
With this potentiometer in its CAL position, the deflection coefficient for external signals is 300 mV/DIV.
The external signal can be either d.c. or a.c. coupled (lower frequency limit 10 Hz) by depressing either the DC or the LF push-button of the trigger coupling controls of the main time-base.

2.2.3.3. AC/0/DC switch

The signals under observation are fet to input socket(s) A and/or B and the AC/0/DC switch is set to either AC or DC, depending upon the composition of the signal. As the vertical amplifier is d.c. coupled, the full bandwidth of the instrument is available and d.c. components are displayed as trace shifts in the DC position of the AC/0/DC switch.
This may be inconvenient when small signals superimposed on high d.c. voltages must be displayed. Any attenuation of the signal will also result in attenuation of the small a.c. component. The remedy is to use the AC position of the input switch, which employs a blocking capacitor, to suppress the d.c. and l.f. signals. Some pulse droop will occur when l.f. square-wave signals are displayed.

The 0 position interrupts the signal and earths the amplifier input for quickly determining the 0 V level.

2.2.4. Triggering

If a signal must be displayed, the horizontal deflection must always be started on one fixed point of the signal in order to obtain a stationary display. The time-base generator is, therefore, started by narrow trigger pulses formed in the trigger unit and controlled by a signal originating from one of the vertical input signals, an internal voltage at mains frequency or an external source.

2.2.4.1. Trigger coupling

Three different trigger-coupling methods can be chosen with the DC/LF/HF switch. In the HF and LF positions, the transfer characteristic is limited.
In position DC the trigger signal is passed unchanged.
In position LF, a 0 Hz (10 Hz for external triggering) to 30 kHz band-pass filter is inserted. This position can be used to reduce interference from noise.
In position HF, a 30 kHz high-pass filter is inserted.
This position can be used to reduce interference from e.g. hum.

2.2.4.2. Selecting the trigger source and setting the trigger level

The trigger signal is obtained from channel A (button A depressed), channel B (button B operated), an external source (button EXT depressed) or from an internal voltage at mains frequency (button MAINS depressed).
The trigger pulse shaper is a dual-controlled multivibrator switched by the output signals of a differential amplifier.
The trigger signal, which is not affected by the continuous AMPLitude control is, together with direct voltages which are adjustable with the LEVEL potentiometer, fed to the inputs of the differential amplifier.
Depending on the LEVEL setting, a certain part of the trigger signal will be amplified by the differential amplifier.
The multivibrator is thus switched at a fixed point of the trigger signal (see Fig. 2.4.). This means that, with the aid of the LEVEL control, it is possible to scan the shape of the trigger signal (in case of internal triggering A or B equal to the shape of the signal to be displayed) and, thus, to choose the point where the multivibrator will be switched.
The LEVEL potentiometer is fitted with a push-pull switch which allows selection of the trigger slope.

2.2.4.3. Automatic triggering

When the AUTOmatic button of the AUTO-TRIG-SINGLE switch is operated, and if there are no trigger pulses available, the time-base generator is automatically free-running.
The trace is, therefore, always visible. The AUTOmatic mode can be used in all cases where also the TRIG mode is usable, except with signal frequencies lower than 10 Hz or pulse trains with an off time exceeding 100 ms.
As soon as trigger pulses are available, the free-running state of the time-base generator is automatically terminated and the time-base generator is triggered again as described in sections 2.2.4.1. and 2.2.4.2.
When the TRIGgered or SINGLE button is operated, the auto-circuit is switched off. The LEVEL setting can also be used in the AUTOmatic mode.

2.2.4.4. SINGLE sweep triggering

When effects which occur only once have to be observed (usually photographed), it is often desirable to ensure that only one sawtooth is generated, even though several trigger pulses might be produced after the phenomenon of interest. Of course, the single sawtooth in question must be triggered by a trigger pulse. To this end, the SINGLE button must be pressed. The first trigger pulse that appears after the button has been released will start the time-base generator.
The time-base generator is then blocked until the SINGLE button is pressed again. The NOT TRIG'D lamp will light up as soon as the SINGLE button has been released, until the trigger pulse arrives.

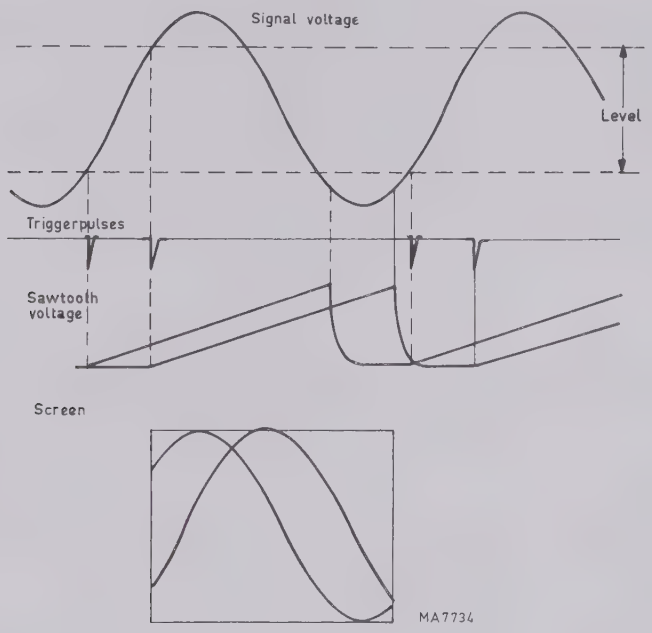

Fig. 2.4. Scanning the waveform by means of the LEVEL potentiometer

2.2.5. Time-base MAGNifier

The time-base magnifier is operated by a two-position push-pull switch incorporated in the horizontal-POSITION control. If this switch is pulled to position x10, the sweep speeds of the main time-base generator are increased by a factor of 10. Thus, the portion of the signal displayed over a width equal to one division in the centre of the screen in the x1 position (T B MAGNifier depressed), will occupy the full width of the screen in the x10 position.
Any portion of the trace can be brought on to the screen by the horizontal-POSITION control for scrutinisation. In the x10 position, the time coefficient is determined by dividing the indicated TIME/DIV value by 10.

2.2.6. Use of the delayed time-base

The delayed time-base can be used for the accurate study of complex signals. When push-button STARTS of the STARTS/TRIG controls is operated, immediately the delayed-time base is on (i.e. the TIME/DIV switch is not at OFF), a portion of the displayed signal is intensified in the MAIN TB position of the horizontal deflection controls. The DELAY TIME control enables this intensified portion to be shifted along the time axis. The duration of the intensified portion, its length, can be controlled in steps and continuously by means of the TIME/DIV controls of the delayed time-base generator. When push-button DEL'D TB of the horizontal deflection controls is operated, the intensified portion occupies the full width of the screen. In the DEL'D TB position, the delay time, (i.e. the interval between the starting point of the main time-base and the starting point of the delayed time-base) is determined by the settings of the main TIME/DIV controls and the DELAY TIME control.

If the TRIG button of the STARTS/TRIG controls is operated, the delayed time-base is started by the first trigger pulse that occurs after the selected delay time. This trigger pulse is supplied by the trigger unit of the delayed time-base generator. This position is used when time jitter would otherwise give a blurred image of the detail under observation. This time jitter could be part of the signal being investigated or, at extreme magnifications, originate in the time-base circuits.

Bedienungsanleitung

1. Allgemeines

1.1. EINLEITUNG

Der tragbare Oszillograf PM 3260 gestattet Messungen von Signalen bei hoher Empfindlichkeit (5 mV/Teil) über eine grosse Bandbreite (120 MHz). Der Oszillograf ist mit vielen Dünnfilmschaltungen bestückt, wodurch ein stabiler Betrieb gewährleistet ist und die Zahl der Abgleichorgane verringert wird.
Es gibt eine grosse Auswahl von Darstellungsmöglichkeiten.
Es können ein oder zwei Kanäle dargestellt werden.
Die Addition beider Kanäle ist ebenfalls möglich.
Durch die Invertierungsmöglichkeit beider Kanäle können auch Differenzen gebildet werden.
Der Oszillograf ist mit einer Hauptzeitablenkung und einer verzögerten Zeitablenkung ausgerüstet.

Der PM 3260 hat eine Speisung mit niedriger Verlustleistung, die bei jeder beliebigen Wechselspannung zwischen 90 V und 264 V betriebsfähig ist, wodurch sich eine Einstellung auf die örtliche Netzspannung erübrigt.

Durch all diese Eigenschaften eignet sich der Oszillograf für einen grossen Einsatzbereich.

Oszillograf PM 3260E ist ein ähnliches Gerät, jedoch ohne kalibrierten DELAY TIME Knopf und ohne Messkopfspeisung.

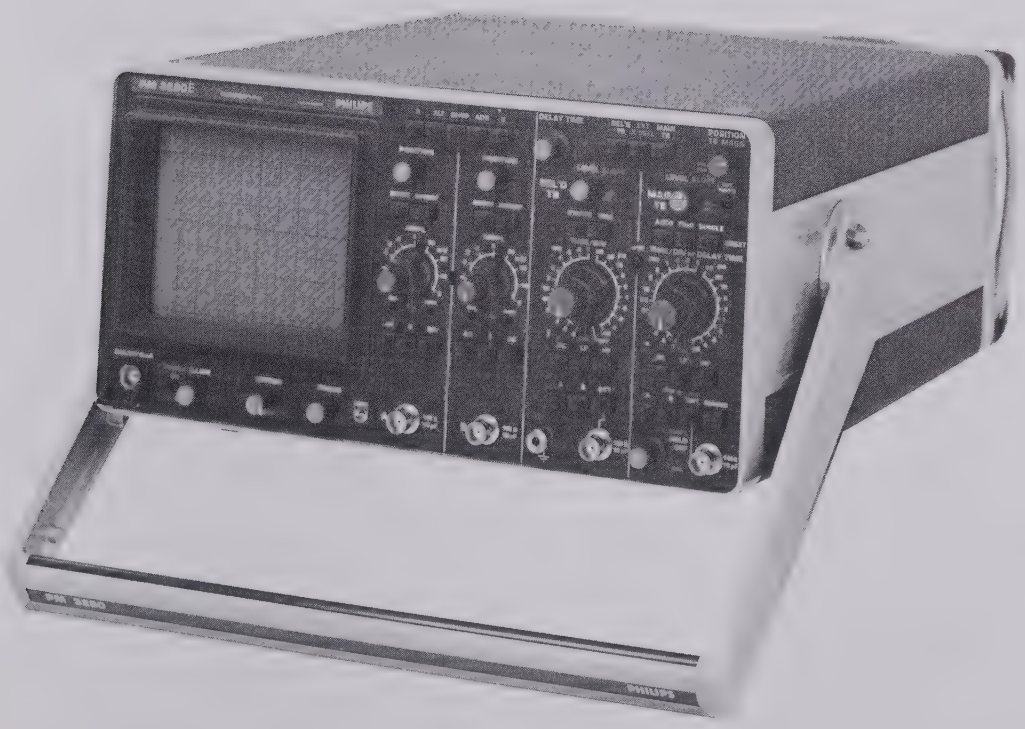

Abb. 1.1. Tragbarer Zweistrahl-Oszillograf PM 3260.

1.2. TECHNISCHE DATEN

Diese Spezifikation gilt nach 15 Minuten Anwärmzeit des Gerätes. Zahlenwerte mit Toleranzangabe werden garantiert. Zahlenwerte ohne Toleranzangabe geben die Eigenschaften eines durchschnittlichen Gerätes an und sind nur zur Orientierung.

Benennung	Beschreibung	Nähere Angaben
1.2.1. ELEKTRONENSTRAHLRÖHRE		
Typ	PHILIPS D14-240	Rechteckiger Schirm, mit Netzelektrode und Nachbeschleunigung, metallhinterlegter Leuchtschirm.
Ausnutzbare Schirmfläche	80 mm x 100 mm	
Schirmtyp	P31 (GH) Phosphor	P7 (GM) Phosphor auf Wunsch lieferbar
Photografische Schreibgeschwindigkeit	1500 cm/μs	Gemessen mit Steinheil Oscillophot M5 Kamera. Blende: 1:1,2 Bildausschnitt Verhältnis: 1:0,5 Film: Polaroid 410 (10000 ASA) Keine Vorbelichtung Phosphor Typ P31 (GH)
Gesamte Beschleunigungsspannung	20 kV	
Raster	Intern	Stufenlos einstellbare Rasterbeleuchtung
Einleitung	Zentimetereinteilung mit Untereinteilung von 2 mm an den mittleren Achsen. Gestrichelte Linien bei 10 % und 90 % des Messrasters, zur Messung von Anstiegzeiten	
1.2.2. VERTIKALE ODER Y-ACHSE		
1.2.2.1. Kennlinie		
Frequenzbereich	d.c. ... 120 MHz 10 Hz ... 120 MHz	–3 dB, Gleichspannungskopplung –3 dB, Wechselspannungskopplung
Anstiegzeit	$\approx$ 3 ns	
Überschwingen	±3 % (4 % Spitze-Spitze)	
1.2.2.2. Ablenkkoeffizienten	5 mV/Teil ... 2 V/Teil	Neun kalibrierte Stellungen, Folge 1-2-5. Nicht kalibriert stufenlos einstellbar 1 : $\geqslant$ 2,5
1.2.2.3. Fehlergrenze	±3 %	
1.2.2.4. Hochstzulässige Eingangsspannung	±400 V 800 V_{ss}, Wechselspannung	Gleichspannung + Spitzenwert einer Wechselspannung. Bis zur 20 mV Stellung des Eingangsabschwächers Minderung bei Frequenzen über 500 kHz. Siehe Abbildung 1.2.
1.2.2.5. Instabilität des Leuchtflecks		
Bildsprung	$<$ 0,3 Teil	Beim Schalten zwischen den Stellungen des Abschwächers
Bildsprung	$<$ 0,3 Teil	Beim Schalten des NORM/INVERT Schalters
Bildverschiebung	$<$ 0,3 Teil	Beim Drehen des kontinuierlichen Abschwächers
Bildverschiebung	$<$ 1 Teil	Beim Eindrücken der Taste ADD.
Temperatur Drift	60 μV/^{o}C	Mittelwert

Benennung	Beschreibung	Nähere Angaben
1.2.2.6. Maximale Ablenkung		
Unverzerrt	24 Teile	
Verschiebungbereich	16 Teile	8 Teile über und unter mittleren Rasterlinie.
1.2.2.7. Eingangsimpedanz	1 MOhm//15 pF	
1.2.2.8. Zeitkonstante der Eingangsschaltung	⩾ 17 ms	Kopplungsschalter auf AC
1.2.2.9. Sichtbare Signalverzögerung	ca. 30 ns	
1.2.2.10. Darstellungsmöglichkeiten	nur Kanal +A oder −A nur Kanal +B oder −B Kanäle ±A und ±B zerhackt Kanäle ±A und ±B abwechselnd Kanäle ±A und ±B addiert	
1.2.2.11. Chopperfrequenz	≈ 1 MHz	
1.2.2.12. Übersprechen zwischen Kanälen	1:500	2 Teile Signalamplitude bei 50 MHz auf einem Kanal, eingestellt auf 0.2 V/Teil. Übersprechen wird gemessen am anderen Kanal, eingestellt auf 20 mV/Teil.
1.2.2.13. Gleichtaktunterdrückung	100 bei 100 kHz 100 bei 1 MHz 20 bei 50 MHz	Gemessen mit +A und −B Addiert Max. Gleichtaktsignal 8 Teile
1.2.3. HORIZONTALE ODER X ACHSE		
1.2.3.1. Darstellungsweisen	– Hauptzeitablenkung – Hauptzeitablenkung aufgehellt durch verzögerte Zeitablenkung – Verzögerte Zeitablenkung – XY-Betrieb	X Ablenkung durch: – Kanal A Signal – Kanal B Signal – Signal über EXT Anschluss der Hauptzeitablenkung – Netzfrequenz
1.2.4. HAUPTZEITABLENKUNG		
1.2.4.1. Betriebsart	Getriggert Automatisch Einmalig	Automatischer Freilauf bei Abwesenheit von Triggersignalen möglich
1.2.4.2. Zeitmassstäbe	1 s/Teil ... 50 ns/Teil	In 23 Kalibrierten Stufen, Folge 1-2-5. Dazwischen stufenlos einstellbar 1 : ⩾ 2,5 nicht kalibriert
1.2.4.3. Fehlergrenze des Zeitmassstabes	±2 % ±3 %	+20 °C ... +30 °C + 5 °C ... +40 °C Zeitablenkungs-Genauigkeit für 2 beliebige Teile von 10-Teil-Zeitablenkung ist ±5 %. Die ersten und letzten Teile der 5 ns und 10 ns gedehnten Zeitablenkung sind auszuschliessen.

Benennung	Beschreibung	Nähere Angaben
1.2.4.4. Anzeigendehnung		
Dehnung	10x	Geschaltet, kalibriert
Zusätzliche Abweichung	±1 %	Erste und letzte 50 ns von 5 ns, 10 ns und 20 ns der gedehnten Zeitablenkung sind auszuschliessen
Kürzester Zeitmassstab	5 ns/Teil	
1.2.4.5. Regelbare Sperrzeit	Die Zeitablenk-Sperrzeit kann ca. 10x erhöht werden	
1.2.5. VERZÖGERTE ZEITABLENKUNG		
1.2.5.1. Betriebsart	Verzögerte Zeitablenkung startet nach Wahl, entweder sofort nach Ablauf der Verzögerungszeit oder nach Empfang des ersten Triggerimpulses nach Verstreichen der Verzögerungszeit	
1.2.5.2. Zeitmassstäbe	0,5 s/Teil ... 50 ns/Teil	In 22 kalibrierten Stufen (Folge 1-2-5). Dazwischen stufenlos einstellbar 1 : ⩾ 2,5 nicht kalibriert.
1.2.5.3. Fehlergrenze des Zeitmassstabes	±2 % ±3 %	+20 °C ... +30 °C + 5 °C ... +40 °C Zeitablenkungs-Genauigkeit für zwei beliebige Teile von 10-Teil-Zeitablenkung ist ±5 %. Die ersten und letzten Teile der 5 ns und 10 ns gedehnten Zeitablenkung sind auszuschliessen.
1.2.5.4. Verzögerungszeit	Stufenlos zwischen 0x und 10x der Zeitkoeffizient, der Hauptzeitablenkung	Kalibriert in der Standardausführung PM 3260. Bereich des Verzögerungszeitvervielfachers 0.00-9.99. Inkrementale Genauigkeit 0,5 %, typisch 0,2 %. Nicht kalibriert in der PM 3260E Ausführung.
1.2.5.5. Verzögerungszeitjitter	< 1:20.000	Mittelwert 1:30.000
1.2.6. X ABLENKUNG		
X Ablenkung über Y_A		
1.2.6.1. Ablenkkoeffizient	5 mV/Teil ... 2 V/Teil	Nicht kalibriert stufenlos einstellbar 3:1 über potentiometer X AMPL
1.2.6.2. Koeffizientabweichung	±5 %	
1.2.6.3. Bandbreite	0 ... 2 MHz	–3 dB Bandbreite über 8 Teile
1.2.6.4. Eingangsimpedanz	1 MOhm//15 pF	
1.2.6.5. Phasenverschiebung	3° bei 100 kHz	
Externe X Ablenkung über Buchse EXT		
1.2.6.6. Ablenkkoeffizient	300 mV/Teil	Eine kalibrierte Stellung Nicht kalibriert stufenlos einstellbar ⩾ 3:1
1.2.6.7. Bandbreite	0 ... 2 MHz	–3 dB Bandbreite über 8 Teile
1.2.6.8. Eingangscharakteristiken	Gleiche Werte wie Y Kanäle	
1.2.6.9. Phasenverschiebung	3° bei 100 kHz	

Benennung	Beschreibung	Nähere Angaben
X Ablenkung mit interner Spannung bei Netzfrequenz		
Die Ablenkung ist von der Netzspannung abhängig und ist bei Lieferung auf 8 Teile bei einer Netzspannung von 220 V eingestellt.		
1.2.7. TRIGGERUNG DER HAUPTZEITABLENKUNG		
1.2.7.1. Triggerquelle	Intern von Kanal A Intern von Kanal B Intern von Netz Extern	
1.2.7.2. Betriebsart	Automatische Triggerung	Automatischer Freilauf des Zeitablenkgenerators etwa 100 ms nach Verschwinden des Triggersignals.
	Normale Triggerung Einmaliger Ablauf der Zeitablenkung	
1.2.7.3. Triggerflanke	+ oder –	
1.2.7.4. Triggerempfindlichkeit	Intern ⩽ 0,5 Teil Extern ⩽ 150 mV	Typischer Wert als Funktion der Frequenz, siehe Abb. 1.3
1.2.7.5. Filterbandbreite	DC 0-120 MHz	Flache Wiedergabekennlinie, intern sowie extern
	LF: 0-30 kHz LF: 10 Hz-30 kHz HF: 30 kHz-120 MHz	–3 dB, Intern –3 dB, Extern –3 dB, Intern und Extern
1.2.7.6. Pegelbereich	24 Teile –3,6 V bis +3,6 V	Bei interner Triggerung Bei externer Triggerung
1.2.7.7. Eingangscharakteristiken	gleicher Wert wie Y-Kanäle	
1.2.8. TRIGGERUNG DER VERZÖGERTEN ZEITABLENKUNG		
1.2.8.1. Triggerquelle	Intern von Kanal A Intern von Kanal B Extern	
Übrige Eigenschaften sind die gleichen wie bei TRIGGERUNG DER HAUPTZEITABLENKUNG		
1.2.9. KALIBRIERUNGSEINHEIT		
1.2.9.1. Ausgangsspannung	3 V_{ss}	
1.2.9.2. Ausgangsstrom	6 mA	
1.2.9.3. Fehlergrenze	±1 %	Spannung und Strom
1.2.9.4. Frequenz	2 kHz ± 2 %	
1.2.9.5. Sicherung	Der Ausgang ist gegen Dauerkurzschlüsse gesichert	
1.2.10. STROMVERSORGUNG		
1.2.10.1. Netzspannungen	Jede Spannung zwischen 100 und 240 V ± 10 % in einem Bereich	
1.2.10.2. Netzfrequenz	46-440 Hz	
1.2.10.3. Messkopfspeisung	+ und –24 V	Bei Ausführung PM 3260E nicht eingebaut
1.2.10.4. Leistungsbedarf	45 W	

Benennung	Beschreibung	Nähere Angaben
1.2.11. UMGEBUNGSEIGENSCHAFTEN		
1.2.11.1. Umgebungstemperaturen	+5 °C ... +40 °C −10 °C ... +55 °C −40 °C ... +70 °C	Betrieb innerhalb Spezifikation Arbeitsbereich Lagerung und Transport
1.2.11.2. Höhe	5000 m 15000 m	Betriebsfähig nicht Betriebsfähig
1.2.11.3. Feuchtigkeit	Das Gerät entspricht den Anforderungen gemäss IEC 50 (CO) 142 Standard.	
1.2.11.4. Stossfestigkeit	Das Gerät entspricht den Anforderungen gemäss IEC 68 Eb Standard	
1.2.11.5. Vibration	Das Gerät entspricht den Anforderungen gemäss IEC 68 F Standard	
1.2.11.6. Akklimationszeit	15 Minuten für Normalbetrieb	Kommend von −10 °C nach +20 °C bei 60 % relativer Feuchtigkeit
1.2.12. MECHANISCHE DATEN		
1.2.12.1. Abmessung	Länge 410 mm Breite 316 mm Höhe 154 mm	Ohne Bedienungsorgane, Deckel und Füsse
1.2.12.2. Gewicht	9,3 Kg	

1.2.13. ZUBEHÖR

1.2.13.1. Standardzubehör

2 Kontrastfilterscheiben
Abdeckhaube mit Aufbewahrungsraum
Faltbarer Lichtschutztubus PM 9366
BNC Übergangsstecker PM 9051
CAL Anschlussklemme - BNC Adapter
Anleitung

1.2.13.2. Wahlzubehör

PM 9335	Passiver 1:1 Messkopf
PM 9351	Passiver 10:1 Messkopf
PM 9358	Passiver 100:1 Hochspannungsmesskopf
PM 9347*)	Aktiver T.V. Messkopf
PM 9352*)	Aktiver Miniatur Messkopf
PM 9353*)	Aktiver FET-Messkopf
PM 8960	Anpassung für Gestelleinbau
PM 8971	Kamera Flansch
PM 9380	Oszillografenkamera Serie Oszillografenkameras Steinheil Oszillophot

*) Falls diese Messköpfe mit PM 3260E benutzt werden sollen muss zusätzlich die Stromversorgung PM 9346 eingesetzt werden.

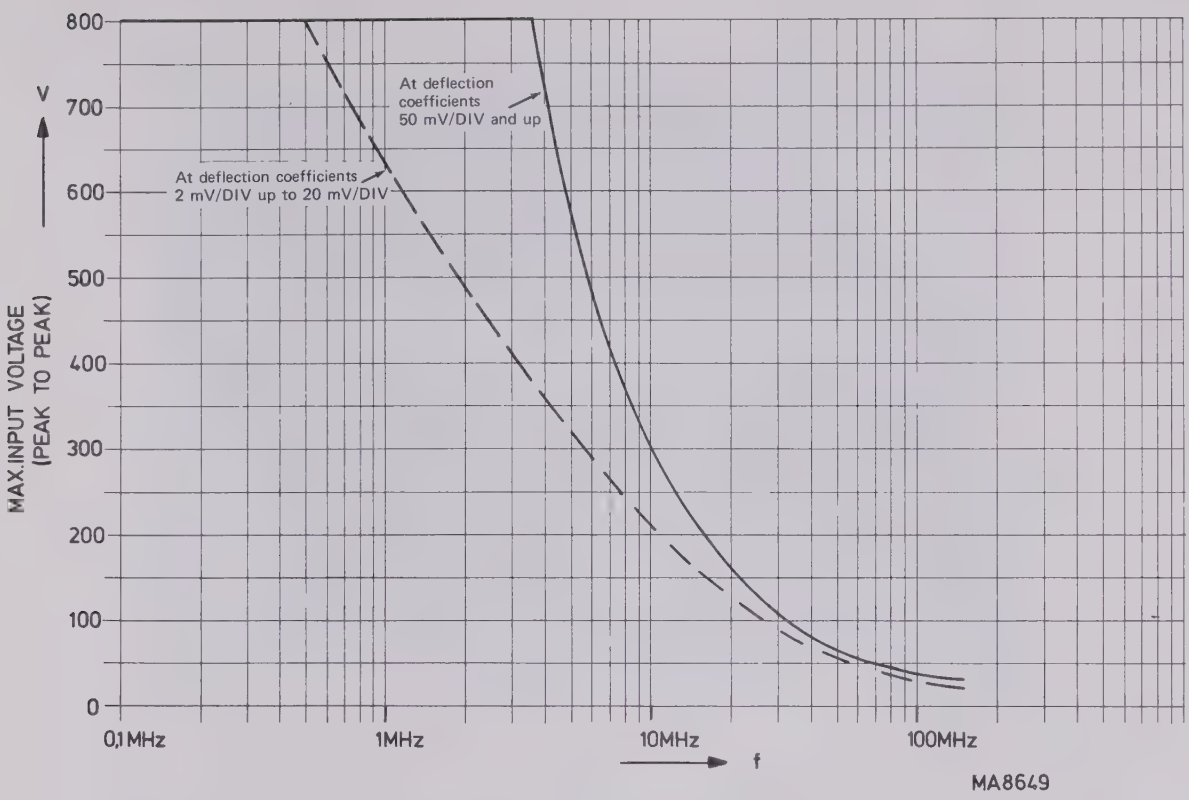

Abb. 1.2. Minderung der höchstzulässigen Eingangsspannung

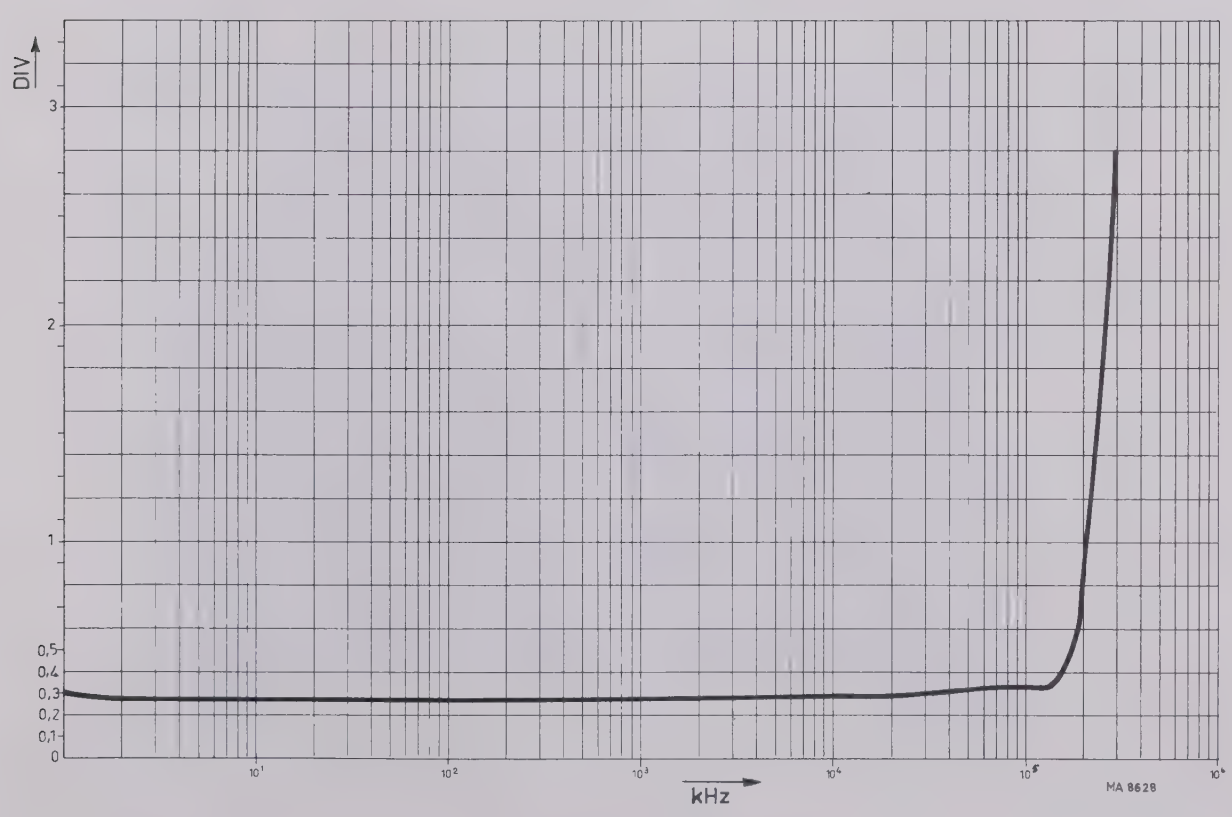

Abb. 1.3. Typische Ablenkempfindlichkeit für interne Triggerung über Kanal A

Abb. 2.1. Abnehmen der Abdeckhaube

Abb. 2.2. Rückansicht des Gerätes

2. Gebrauchsanweisung

2.1. INBETRIEBNAHME

2.1.1. Abnehmen und Aufsetzen der Abdeckhaube

Abnehmen: – Den Knopf in der Mitte des Deckels eine viertal Umdrehung nach links drehen (Stellung UNLOCKED)
– Deckel abnehmen.

Aufsetzen: – Den Verriegelungsknopf in Stellung UNLOCKED drehen.
– Deckel an der Vorderseite des Oszillografen befestigen.
– Knopf eindrücken und eine viertel Umdrehung nach rechts drehen (Stellung LOCKED).

Bemerkung: Der Handgriff lässt sich drehen wenn die Druckknöpfe auf ihren Lagern eingedrückt werden.

Warnung: In diesem Gerät werden hohe Spannungen erzeugt, deshalb darf es niemals in geöffnetem Zustand eingeschaltet werden.
Vor Wartungsarbeiten ist der Netzstecker zu ziehen und ist darauf zu achten dass alle Hochspannung führenden Teile entladen sind.

2.1.2. Netzspannungseinstellungen und Sicherung

Da das Gerät bei jeder Netzspannung zwischen 90 und 264 V betriebsfähig ist, erübrigt sich das Umschalten auf die örtliche Netzspannung.
Der Sicherungshalter an der Rückwand enthält eine Sicherung von 2 A, träge. Die Verwendung reparierter Sicherungen und das Kurzschliessen des Sicherunghalters sind verboten.

2.1.3. Erdung

Aus Sicherheitsgründen muss der Oszillograf entweder über den Erdanschluss an der Rückseite (gekennzeichnet ⏚), oder über das Netzkabel, vorausgesetzt das Gerät wird an eine Schukosteckdose angeschlossen, geerdet werden.
Es ist zu beachten dass die Erdverbindung des Oszillografen nicht durch ein Verlängerungskabel oder irgendeine andere Vorrichtung unterbrochen wird, die keinen Erdleiter besitzt.

2.1.4. Einschalten

Der Schalter POWER ist gekoppelt mit der Rasterbeleuchtungseinsteller ILLUM und befindet sich an der Vorderseite des Gerätes unter dem Bildröhrenrahmen.
Der Oszillograf darf niemals eingeschaltet werden, wenn eine Leiterplatte oder Baustein entfernt wurde.
Eine Leiterplatte oder Baustein darf nicht früher als eine Minute nach Ausschaltung des Gerätes entfernt werden.

2.2. BEDIENUNGSANLEITUNG

Vor dem Einschalten ist zu kontrollieren, ob der Oszillograf gemäss Abschnitt 2.1. "INBETRIEBNAHME" angeschlossen ist, und ob die dort erwähnten Vorsorgemassnahmen beachtet wurden.

2.2.1. **Bedienungsorgane und Buchsen** (Abb. 2.3.)

2.2.1.1. Vertikalkanäle

A/ALT/CHOP/ADD/B	Einstellung der Darstellungsarten, Drucktastenschalter mit 5 Stellungen.
A eingedrückt	Vertikalablenkung durch Signal von Kanal A.
ALT eingedrückt	Das Bild wird am Ende (jeder Periode) des Zeitablenksignales von einem Vertikalkanal auf den anderen umgeschaltet.
CHOP eingedrückt	Das Bild wird mit einer Festfrequenz von einem Kanal auf den anderen umgeschaltet.
ADD eingedrückt	Vertikalablenkung durch die Summe der Signale von Kanal A und B.
B eingedrückt	Vertikalablenkung durch Signal von Kanal B. Wird keine Taste eingedrückt ist die Betriebsweise des Gerätes wie bei Einstellung ALT.
POSITION	Stufenlose Einstellung der vertikalen Lage des Bildes.
NORM/INVERT	Drucktastenschalter mit zwei Stellungen zur Umkehrung der Signalpolarität. Ist keine Taste eingedrückt so gilt Einstellung NORM.
AMPL	Stufenweise Einstellung der Vertikalablenkkoeffizienten. Wahlschalter mit 9 Stellungen.
AMPL/CAL	Stufenlose Einstellung der Vertikalablenkkoeffizienten. In Stellung CAL ist der Ablenkkoeffizient kalibriert.
BAL (Schraubenziehereinstellung)	Stufenlose Einstellung des Gleichspannungsgleichgewichtes des Vertikalverstärkers.
GAIN (Schraubenziehereinstellung)	Stufenlose Einstellung der Gesamtverstärkung der Vertikalkanäle.
AC/0/DC	Signalkopplung, Drucktastenschalter mit 3 Stellungen.
AC eingedrückt	Kopplung über einen Sperrkondensator.
0 eingedrückt	Verbindung zwischen Eingangsschaltung und Eingangsbuchse wird unterbrochen und der Verstärkereingang geerdet.
DC eingedrückt	Direkte Kopplung Ist keine Taste eingedrückt so gilt Einstellung AC.
A 1 MOhm - 15 pF	BNC Eingangsbuchse für Kanal A
B 1 MOhm - 15 pF	BNC Eingangsbuchse für Kanal B

2.2.1.2. Horizontaler Kanal

DEL'D TB - EXT. X DEFL. - MAIN TB	Einstellung der Horizontalablenkung, Drucktastenschalter mit 3 Stellungen.
DEL'D TB eingedrückt	Die Horizontalablenkspannung wird vom verzögerten Zeitablenkgenerator geliefert.
EXT. X DEFL eingedrückt	Horizontalablenkung durch das Signal von Kanal A, das Signal von Kanal B oder durch ein Netzfrequenzsignal.
MAIN TB eingedrückt	Horizontalablenkspannung wird vom Hauptzeitablenkgenerator geliefert; ein Teil der Darstellung wird aufgehellt (Ausgenommen in Stellung OFF des TIME/DIV Schalters des verzögerten Zeitablenkgenerators). Ist keine Taste eingedrückt so gilt Einstellung MAIN TB.

POSITION TB MAGN	Stufenlose Einstellung der horizontalen Lage des Bildes; gekoppelt mit einem Zug-Druck-Schalter der den Horizontalablenkkoeffizienten 10 mal steigert. Eine Signallampe leuchtet auf wenn die Dehnung x10 eingeschaltet ist.
X AMPL/HOLD OFF	Stufenlose Einstellung des Horizontalablenkkoeffizienten bei externer X-Ablenkung. Bei X-Ablenkung durch die Hauptzeitablenkung kann diese Einstellung zur Steigerung der Sperrzeit benutzt werden.

2.2.1.3. Hauptzeitablenkgenerator

LEVEL	Stufenlose Einstellung des Triggersignalpegels bei welchem der Zeitablenkgenerator startet. Diese Einstellung ist gekoppelt mit einem Zug-Druck-Schalter zur Triggerungswahl auf der positiv oder negativ gerichteten Flanke des Triggersignales.
NOT TRIG'D	Signallampe leuchtet auf bei Wartestellung des Zeitablenkgenerators.
AUTO - TRIG - SINGLE	Triggerart-Einstellungen; Drucktastenschalter mit 3 Stellungen.
AUTO eingedrückt	Liegt kein Triggersignal an so läuft der Hauptzeitablenker frei.
TRIG eingedrückt	Der Zeitablenkgenerator wird auf normale Weise getriggert.
SINGLE eingedrückt	Nach Betätigung der Taste SINGLE, läuft der Zeitablenkgenerator nach Empfang eines Triggersignals nur einmal ab.

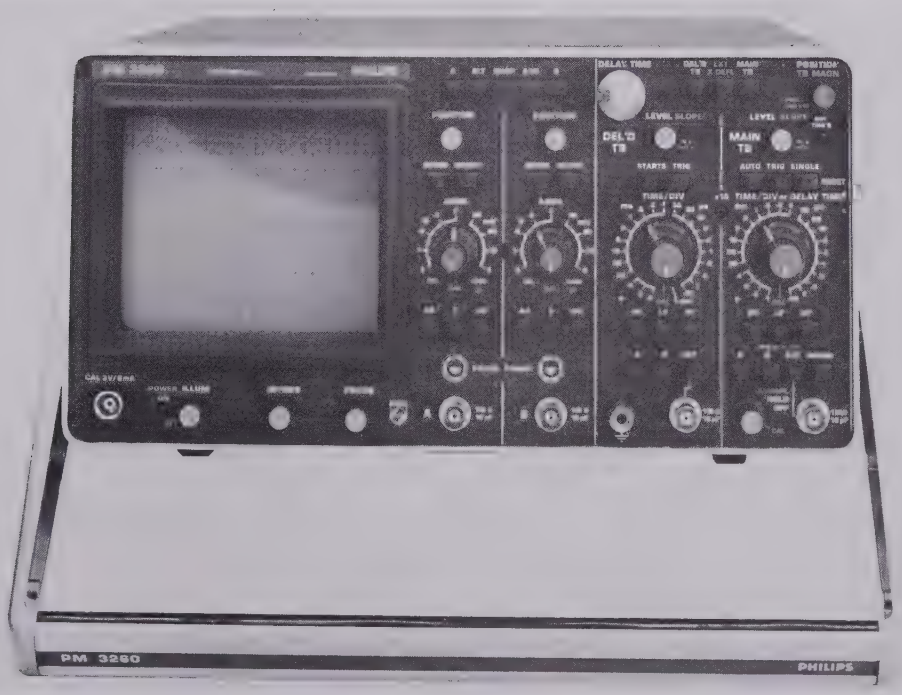

Abb. 2.3. Vorderansicht des Gerätes

TIME/DIV or DELAY TIME	Einstellung des Zeitkoeffizienten der Hauptzeitablenkung; Drehschalter mit 23 Stellungen.
TIME/DIV-CAL (blau)	Stufenlose Einstellung des Zeitkoeffizienten der Hauptzeitablenkung. In Stellung CAL ist der Zeitkoeffizient kalibriert.
DC-LF-HF	Triggerkopplung; Drucktastenschalter mit 3 Stellungen.
DC	Triggersignale direkt gekoppelt.
LF	Kopplung über Tiefpass für Frequenzen bis 30 kHz (für externe Triggerung über einen Bandfilter von 10 Hz bis 30 kHz).
HF	Kopplung über Hochpass für Frequenzen über 30 kHz. Ist keine Taste eingedrückt so gilt Einstellung DC.
TRIG oder X DEFL	Wähler für Triggerquelle oder externe X Ablenkung. Drucktastenschalter mit 4 Stellungen.
A	Internes Trigger- oder X-Ablenksignal von Kanal A.
B	Internes Trigger- oder X-Ablenksignal von Kanal B.
EXT	Triggerung auf externes Signal über angrenzende 1 MOhm - 15 pF Buchse. Durch eindrücken der Taste EXT X-DEFL der Horizontalablenkungs-Einstellung wird diese Buchse mit dem Eingang des Horizontalverstärkers verbunden.
MAINS	Triggerung- oder X-Ablenkungssignal von einer internen Spannung mit der Netzfrequenz. Ist keine Taste eingedrückt so gilt Einstellung A.
1 MOhm - 15 pF	BNC Buchse für externe Triggerung oder Horizontalablenkung.

2.2.1.4. Verzögerter Zeitablenkgenerator

DELAY TIME	Stufenlose Einstellung der Verzögerungszeit, wirkt zusammen mit der TIME/DIV Einstellung des Hauptzeitablenkgenerators.
LEVEL SLOPE	Stufenlose Einstellung zur Pegelwahl des Triggerungsignals, bei welchem der verzögerte Zeitablenkgenerator startet. Diese Einstellung ist gekoppelt an einen Zug-Druck-Schalter zur Triggerungswahl auf der positiv oder negativ gerichteten Flanke des Triggersignals.
STARTS - TRIG	Wahl des Anfangspunktes des verzögerten Zeitablenkgenerators nach Ablauf der eingestellten Verzögerungszeit. Drucktastenschalter für 2 Einstellungen.
STARTS	Der verzögerte Zeitablenkgenerator wird sofort nach Ablauf der Verzögerungszeit gestartet.
TRIGG	Der verzögerte Zeitablenkgenerator wird nach Ablauf der Verzögerungszeit nach Erhalt eines Triggerimpulses gestartet. Ist keine Drucktaste eingedrückt so gilt Einstellung STARTS.
TIME/DIV	Einstellung des Zeitkoeffizienten der verzögerten Zeitablenkung. Drehschalter mit 23 Stellungen. In Stellung OFF wird die verzögerte Zeitablenkung abgeschaltet.
TIME/DIV - CAL (blau)	Stufenlose Einstellung des Zeitkoeffizienten der verzögerten Zeitablenkung. In Stellung CAL ist der Zeitkoeffizient kalibriert.
DC - LF - HF	Triggerkopplung; Drucktastenschalter mit 3 Stellungen.
DC	Triggersignale direkt gekoppelt.
LF	Kopplung über Tiefpass für Frequenzen bis 30 kHz (für externe Triggerung über einen Bandfilter von 10 Hz bis 30 kHz).
HF	Kopplung über Hochpass für Frequenzen über 30 kHz. Ist keine Taste eingedrückt so gilt Einstellung DC.

A - B - EXT	Triggerquellen Einstellung; Drucktastenschalter mit 3 Stellungen.
A	Internes Triggerungssignal von Kanal A.
B	Internes Triggerungssignal von Kanal B.
EXT	Triggerung auf ein externes Signal über angrenzende 1 MOhm - 15 pF Buchse. Ist keine Taste eingedrückt so gilt Einstellung A.
1 MOhm - 15 pF	BNC Eingangsbuchse für externes Triggersignal.

2.2.1.5. Elektronenstrahlröhre

ILLUM POWER	Stufenlose Einstellung der Rasterbeleuchtung; zugleich Netzschalter. Signallampe zeigt Betriebszustand (ON) an.
INTENS	Stufenlose Einstellung der Helligkeit des Bildes.
FOCUS	Stufenlose Einstellung zur Fokussierung des Elektronenstrahls.

2.2.1.6. Verschiedenes

CAL	Ausgangsbuchse an der eine Rechteckspannung von 3 V_{ss} und ein Strom von 6 mA mit einer Frequenz von 2 kHz zur Verfügung steht. Amplituden-Genauigkeit: ±1 %. Frequenz-Genauigkeit: ±2 %. Der Ausgang ist gegen Dauerkurzschlüsse gesichert.
PROBE POWER	Speisungsbuchse für aktives Zubehör; liefert +24 V und −24 V.
⏚	Messerde

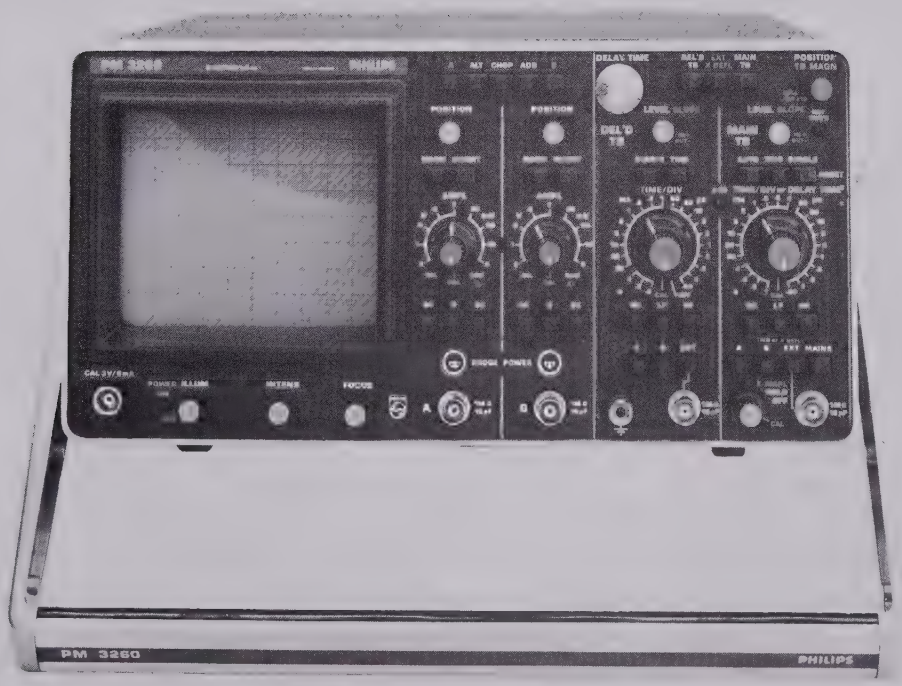

Abb. 2.3. Vorderansicht des Gerätes

2.2.2. Vorbereitende Einstellungen

Da die folgenden Einstellungen für beide vertikale Kanäle gleich sind, ist nur die Vorschrift für Kanal A gegeben.

2.2.2.1. Einstellen Gleichspannungsgleichgewicht

- Drucktaste A des Darstellungsartenschalters betätigen.
- Drucktaste AUTO des Triggerartenschalters betätigen.
- Drucktaste MAIN TB des Horizontalablenkungsschalters betätigen.
- Schalter AMPL in Stellung 5 mV und stufenlosen Einsteller in Stellung CAL bringen.
- Bild mit Einsteller POSITION zentrieren.
- Mit Einstellern INTENS und FOCUS die Schärfe des Bildes regeln.
  Nicht erwähnte Einstellungen dürfen in jeder beliebigen Stellung stehen.
- Es ist darauf zu achten dass das Bild nicht springt, wenn der Schalter zwischen der 5- und 10 mV-Stellung betätigt wird.
  Nötigenfalls Einstellung BAL an der Vorderseite unter dem Schalter AMPL erneut einstellen.

2.2.2.2. Verstärkungseinstellung

Falls nicht anders angegeben sind die Bedienungsorgane in den selben Stellungen wie in vorgehender Einstellvorschrift.

- Schalter AC-0-DC in Stellung DC.
- Schalter AMPL in Stellung 0,5 V und stufenlosen Einsteller in Stellung CAL.
- Buchse CAL mit Eingangsbuchse A verbinden.
- Prüfen ob die Bildhöhe 6 Teile beträgt.
  Nötigenfalls Einstellung GAIN unter dem Schalter AMP neu einstellen.

2.2.3. Eingänge A und B und ihre Möglichkeiten

Der Oszillograf besitzt zwei identische Kanäle, die entweder zusammen mit einem oder beiden Zeitablenkgeneratoren für YT Messungen, oder aber zusammen mit dem externen Horizontalkanal für XY Messungen verwendet werden können.

2.2.3.1. YT-Messungen

Zur Darstellung eines Signals ist einer der beiden Vertikalkanäle mit Taste A oder Taste B der Darstellungsartenschalter zu wählen.
Wird Taste ALT oder CHOP gedrückt, können zwei verschiedene Signale gleichzeitig abgebildet werden. Der Y-Ablenkkoeffizient und die Polarität können für jeden Kanal getrennt gewählt werden. Wird Taste ALT betätigt wird die Darstellung beim Rücklauf des Zeitablenksignals von einem Kanal auf den anderen umgeschaltet. Obwohl Stellung ALT für alle Ablenkzeiten verwendet werden kann, ergibt für lange Ablenkzeiten Stellung CHOPPED eine bessere Bildgüte, da das abwechselnde Darstellen der beiden Eingangssignale während dieser langen Ablenkzeiten deutlicher sichtbar ist.

In Stellung CHOPPED, wird die Darstellung mit einer Festfrequenz von einem Kanal auf den anderen umgeschaltet.
In Stellung ADDED des Darstellungsartenschalters werden die Signalspannungen der beiden vertikalen Kanäle addiert. Abhängig von der Stellung der Polaritätsschalter wird entweder die Summe oder die Differenz der Eingangssignale dargestellt. Die Einstellung ADDED ermöglicht auch Differenzmessungen. Bei diesen Messungen wird die Gleichtaktunterdrückung der Stellung ADDED ausgenützt. Wenn die Polaritätsschalter beider Kanäle in entgegengesetzten Stellungen stehen, werden die Gleichtaktteile der Signale von Kanal A und B im Verhältnis zu den Gegentaktteilen nur sehr geringfügig verstärkt.

2.2.3.2. XY-Messungen

Wenn Drucktaste EXT X DEFL des Horizontalablenkungsschalters und Taste A des TRIG OR X DEFL-Schalters eingedrückt sind ist der Zeitablenkgenerator ausgeschaltet. Ein Signal das über Kanal A zugeführt wird kann nur zur Horizontalablenkung verwendet werden. Der Schalter AC/0/DC und der Stufenabschwächer von Kanal A bleiben wirksam.
Einsteller X DEFL/HOLD OFF ermöglicht stufenlose Einstellung der Ablenkungskoeffizienten, für horizontale Verschiebung des Bildes wird Einsteller X POSITION verwendet.

Für X Ablenkung kann auch der vertikale Kanal B verwendet werden.
In diesem Fall Taste B des TRIG OR X DEFL-Schalters eindrücken.

Es ist ferner möglich eine interne Spannung der Netzfrequenz, oder ein Signal angelegt an die EXT Buchse (Vorderseite rechts unten), für die X-Ablenkung zu verwenden. Zu diesem Zweck die betreffende Drucktaste des TRIG OR X DEFL-Schalters eindrücken.
Bei diesen Betriebsarten kann die Bildbreite mit dem X DEFL/HOLD OFF Potentiometer eingestellt werden. Mit diesem Potentiometer in Stellung CAL, beträgt der Ablenkungskoeffizient für externe Signale 300 mV/Teil.

2.2.3.2. AC/0/DC Schalter

Die zu beobachtenden Signale sind an die Buchse (n) A und/oder B zu legen und der AC/0/DC Schalter abhängig von der Zusammensetzung der Signale auf AC oder DC zu stellen. Da der vertikale Verstärker gleichspannungsgekoppelt ist, ist die ganze Bandbreite des Gerätes verfügbar und die Gleichspannungskomponenten werden in Stellung DC des AC/0/DC-Schalters als Bildverschiebungen sichtbar.
Sind kleine Signale hohen Gleichspannungen überlagert kann dies störend sein. Jede Abschwächung des Signals verursacht auch eine Abschwächung der kleinen Wechselspannungskomponenten. In diesem Falle ist der Eingangsschalter in AC Stellung zu bringen wodurch ein Sperrkondensator die Gleichspannungs- und Niederfrequenz-Signale unterdrückt. Dies hat Dachschräge zur Folge bei Darstellungen von Niederfrequenzsignalen.
Stellung 0 unterbricht das Signal und erdet den Verstärkereingang um den 0 V Pegel schnell bestimmen zu können.

2.2.4. Triggerung

Wenn ein Signal dargestellt werden soll, muss, um ein stillstehendes Bild zu erhalten, die Horizontalablenkung stets an einem festen Punkt des Signals gestartet werden.
Der Zeitablenkgenerator wird folglich von in der Triggereinheit erzeugten schmalen Triggerimpulsen gestartet und durch ein Signal gesteuert das entweder den vertikalen Eingangssignalen, einer internen Netzfrequenzspannung oder einer externen Quelle entstammen kann.

2.2.4.1. Triggerkopplung

Mit Schalter DC/LF/HF kann man drei verschiedene Triggerkopplungsarten wählen. In den Stellungen HF und LF ist die Übertragungscharakteristik begrenzt.
In Stellung DC wird das Triggersignal unverändert durchgelassen.
In Stellung LF wird ein 0 Hz (10 Hz bei externer Triggerung) bis 30 kHz Bandpass eingesetzt. Diese Stellung dient zur Verminderung von Störungen durch Rauschen.
In Stellung HF wird ein 30 kHz Hochpass eingesetzt. Diese Stellung kann zum Herabsetzen von Störungen durch Brummen verwendet werden.

2.2.4.2. Selektieren der Triggerquelle und Einstellen des Triggerpegels

Das Triggersignal kann von Kanal A (Taste A gedrückt), von Kanal B (Taste B gedrückt), von einer externen Quelle (Taste EXT gedrückt) oder einer internen Spannung mit Netzspannung (Taste MAINS gedrückt) entnommen werden.
Der Triggerimpulsformer ist ein zweifach gesteuerter Multivibrator, der von den Ausgangssignalen eines Differenzverstärkers gesteuert wird.
Das Triggersignal, das nicht vom stufenlosen Einsteller AMPL beeinflusst wird, wird zusammen mit Gleichspannungen die mittels Potentiometer LEVEL einstellbar sind, den Eingängen des Differenzverstärkers zugeführt.
Abhängig von der LEVEL Einstellung wird ein bestimmter Teil des Triggersignals durch den Differenzverstärker verstärkt.
Der Multivibrator ist somit auf einen fasten Punkt des Triggersignals geschaltet (Abb. 2.4.). Das bedeutet, dass es mit Hilfe des Einstellers LEVEL möglich ist die Form des Triggersignals abzutasten (bei interner Triggerung A oder B gleich der Form des darzustellenden Signals) und somit den Punkt zu wählen, an dem der Multivibrator umgeschaltet wird.
Der Potentiometer ist mit einem Zug-Druck-Schalter versehen, der die Wahl der Triggerflanke erlaubt.

2.2.4.3. Automatische Triggerung

Wenn Taste AUT des AUTO-TRIG-SINGLE-Schalters gedrückt ist - und wenn keine Triggerimpulse vorhanden sind - ist der Zeitablenkgenerator automatisch freilaufend. Das Bild ist daher stets sichtbar. Die Stellung AUTO kann in allen Fällen verwendet werden in welchen auch Stellung TRIG anwendbar ist, ausgenommen bei Signalfrequenzen niedriger als 10 Hz oder Impulsreihen mit einer "AUS"-Zeit über 100 ms.
Sobald Triggerimpulse vorhanden sind, wird der Freilauf des Zeitablenkgenerators automatisch beendet und der Zeitablenkgenerator erneut getriggert wie erwähnt in Abschnitt 2.2.4.1. und 2.2.4.2.
Wird Taste TRIG oder Taste SINGLE eingedrückt ist die Automatik ausgeschaltet.

2.2.4.4. SINGLE-SWEEP-Triggerung

Wenn einmalige Vorgänge beobachtet (und in der Regel fotografiert) werden müssen, ist es oft wünschenswert dafür zu sorgen, dass nur ein Sägezahn erzeugt wird, selbst wenn möglicherweise nach Darstellung dieses Vorgangs mehrere Triggerimpulse erzeugt würden. Zu diesem Zweck Taste SINGLE eindrücken. Der erste Triggerimpuls, der nach Loslassen der gedrückten Taste erscheint, startet den Zeitablenkgenerator.
Der Zeitablenkgenerator wird dann blockiert bis Taste SINGLE wieder betätigt wird. Die Lampe NOT TRIG'D leuchtet auf sobald Taste SINGLE losgelassen wird und erlischt erst wenn der Sägezahn beendet ist.

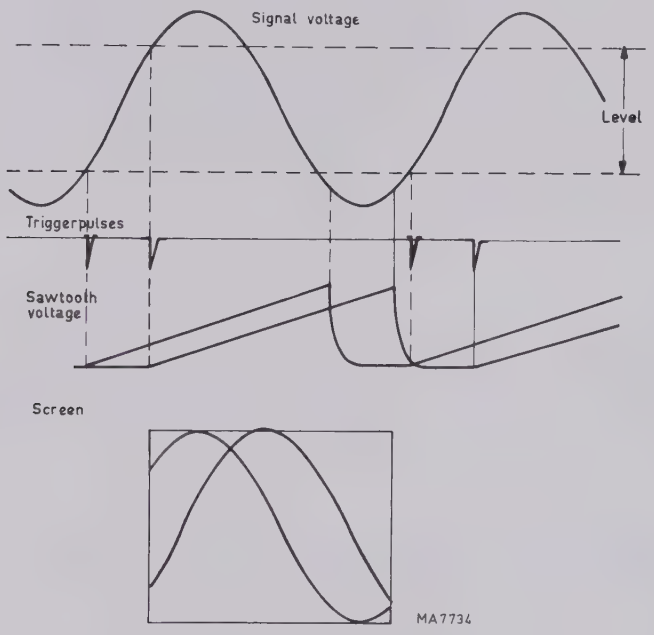

Abb. 2.4. Abtasten der Wellenform mittels des LEVEL Potentiometers

2.2.5. Dehnung der Zeitablenkung

Die Dehnung der Zeitablenkung wird mit einem Zug-Druck-Schalter TB MAGN der an den Einsteller für horizontale POSITION gekoppelt ist, eingestellt. Wenn dieser Schalter in Stellung x10 gezogen ist wird ein 10 mal schnellerer Zeitmassstab des Hauptzeitablenkgenerators eingestellt. Folglich wird der Signalteil, welcher in der x1 Stellung (TB MAGN eingedrückt) über eine Breite von ein Teil (DIV) in der Schirmmitte dargestellt wird, in der x10 Stellung über die Gesamtbreite des Schirmes geschrieben.
Jeder Teil des Bildes kann mit dem horizontalen POSITION Einsteller zur genauen Beobachtung sichtbar gemacht werden.
In der x10 Stellung wird der Zeitkoeffizient durch Teilen des gegebenen Wertes TIME/DIV. durch 10 ermittelt.

2.2.6. Gebrauch der verzögerten Zeitablenkung

Die verzögerte Zeitablenkung kann zur genauen Beobachtung komplexer Signale verwendet werden. Wenn die Drucktaste STARTS des STARTS/TRIG-Schalters nach Einschalten des verzögerten Zeitablenkung (dass heisst TIME/DIV Schalter nicht in Stellung OFF) eingedrückt wird, wird sofort ein Teil des dargestellten Signals in Stellung MAIN TB des Horizontalablenkungs-Schalters zusätzlich aufgehellt. Mit dem DELAY TIME Einsteller ist dieser zusätzlich aufgehellte Teile über die Zeitachse verschiebbar. Die Zeitdauer dieses zusätzlich aufgehellten Teils ist mit den Einstellern TIME/DIV des verzögerten Zeitablenkgenerators sowohl stufenweise wie stufenlos einstellbar. Mit Drucktaste DEL'D TB des Horizontalablenkungs-Schalters wird der zusätzlich aufgehellte Teil über die gesamte Schirmbreite sichtbar gemacht. In Stellung DEL'D TB, wird die Verzögerungszeit (dass heisst die Zeit zwischen dem Startpunkt der Hauptzeitablenkung und dem Startpunkt der verzögerten Zeitablenkung) bestimmt durch die Einstellungen des Schalters TIME/DIV der Hauptzeitablenkung und die des DELAY TIME Einstellers.

In Stellung TRIG des STARTS/TRIG Schalters startet der erste Triggerimpuls nach der gewählten Verzögerungszeit die verzögerte Zeitablenkung. Die Triggereinheit des verzögerten Zeitablenkgenerators liefert diesen Triggerimpuls. Diese Stellung kommt zur Anwendung wenn durch Jitter eine undeutliche Darstellung zu beobachten ist. Dieses Jitter kann durch das beobachtende Signal selbst oder durch externe Dehnung in den Zeitablenkschaltungen entstehen.

Notice d'emploi

1. Généralités

1.1. INTRODUCTION

L'oscilloscope portatif PM 3260 permet de mesurer des signaux de faible amplitude (5 mV/DIV) sur une gamme de fréquence étendue (120 MHz). L'oscilloscope est équipé de nombreux circuits à couche mince qui garantissent un fonctionnement très stable et réduisent le nombre de points de réglage.

Il y a un large choix d'affichages possibles, tels que: l'une ou l'autre voie, deux voies alternées ou commutées, deux voies additionnées, en positions normales et inversées pour les deux signaux d'entrée, avec base de temps principale et retardée.
L'oscilloscope PM 3260 se caractérise par une alimentation à faible dissipation. Cette unité d'alimentation fonctionne pour une tension alternative comprise entre 90 V et 264 V, de sorte qu'il n'est pas nécessaire d'adapter l'appareil à la tension secteur locale.
Toutes ces caractéristiques donnent au présent oscilloscope une grande variété d'applications.

L'oscilloscope PM 3260E est un appareil identique, mais sans multiplicateur du temps de retard étalonné ni alimentation de sonde.

Fig. 1.1. Oscilloscope double trace portatif PM 3260

1.2. CARACTERISTIQUES TECHNIQUES

Les spécifications sont valables après que l'appareil a été préchauffé pendant 15 minutes.
Les valeurs indiquées avec tolérance sont garanties. Les chiffres sans tolérance ne servent qu'à titre d'information et correspondent aux charactéristiques d'un appareil moyen.

Désignation	Spécification	Information supplémentaire
1.2.1. TUBE A RAYONS CATHODIQUES		
Type	PHILIPS D14-240	Tube à face rectangulaire, type domed mesh, post-accélérateur, couche phosphore doublée de métal
Aire de mesure	80 mm x 100 mm	
Type d'écran	Phosphore P31 (GH)	en option, couche phosphore P7 (GM)
Vitesse d'écriture photographique	> 1500 cm/μs	Mesuré avec un appareil photographique Steinheil Oscillophot M5 Ouverture: 1:1,2 Rapport objet/image: 1:0,5 Film: Polaroid 410 (10000 ASA) Pas de pré-voilage Phosphore du type P31 (GH)
Tension d'accélération totale	20 kV	
Graticule	Interne	Illumination continuellement variable
Gravures	Divisions centimétriques avec subdivisions de 2 mm sur les axes centraux. Les lignes interrompues indiquent les points 10 % et 90 % pour la mesure du temps de montée.	
1.2.2. AXE VERTICAL OU Y		
1.2.2.1. Bande passante		
Gamme de fréquence	continu à 120 MHz (–3 dB) 10 Hz ... 120 MHz (–3 dB)	largeur de bande en couplage continu largeur de bande en couplage alternatif
Temps de montée	≈ 3 ns	
Dépassement	±3 % (4 % crête-à-crête)	
1.2.2.2. Coefficients de déviation	5 mV/DIV ... 2 V/DIV	en 9 positions étalonnées (progression 1-2-5) avec commande continue non-calibrée 1 : ⩾ 2,5 par potentiomètre
1.2.2.3. Erreur limite	±3 %	
1.2.2.4. Tension d'entrée maximale admise	±400 V 800 V_{cc} en alternatif	tension continue + tension alternative crête. Jusqu'à la position 20 mV de l'atténuateur d'entrée réduction de la tension d'entrée maximale admise à fréquences > 500 kHz Voir Fig. 1.2
1.2.2.5. Instabilité de la position du spot		
Saut de trace	< 0,3 Div	Lorsque l'on commute l'atténuateur entre deux positions
Saut de trace	< 0,3 Div	Lorsqu'on commute NORM/INVERT
Dérive de trace	< 0,3 Div	Lorsqu'on tourne l'atténuateur continu
Dérive de trace	< 1 Div	En poussant le bouton ADD
Dérive en température	< 60 μV/°C	Valeur typique

Désignation	Spécification	Information supplémentaire
1.2.2.6. Déviation maximale		
Sans distorsion	24 divisions	
Gamme de décadrage	16 divisions	8 divisions vers le haut et vers la bas à partir de la ligne centrale horizontale du graticule
1.2.2.7. Impédance d'entrée	1 MOhm//15 pF	
1.2.2.8. Constant de temps RC d'entrée	⩾ 17 ms	Commutateur de couplage en position AC
1.2.2.9. Retard visible du signal	environ 30 ns	
1.2.2.10. Modes d'affichage	Voie + ou −A seulement Voie + ou −B seulement Voies ±A et ±B découpées Voies ±A et ±B alternées Voies ±A et ±B additionnées	
1.2.2.11. Fréquence de commutation	≈ 1 MHz	
1.2.2.12. Diaphonie entre voies	1 : 500	avec un signal de 2 divisions d'amplitude à 50 MHz sur une voie réglée sur 0,2 V/DIV. La diaphonie est mesurée sur l'autre voie réglée sur 20 mV/DIV
1.2.2.13. Facteur de réjection en mode commun	100 à 100 kHz 100 à 1 MHz 20 à 50 MHz	En mode +A et −B additionés; signal max. en mode commun: 8 div.
1.2.3. AXE HORIZONTAL OU X		
1.2.3.1. Modes de représentation	— Base de temps principale — Base de temps principale intensifiée par base de temps retardée — Base de temps retardée — Fonctionnement XY	 Déviation X par: — le signal voie A — le signal voie B — le signal appliqué au connecteur EXT de la base de temps principale — la fréquence secteur
1.2.4. BASE DE TEMPS PRINCIPALE		
1.2.4.1. Fonctionnements	Déclenché Automatique Balayage unique	En automatique, la base de temps est en fonctionnement libre en l'absence de signaux de déclenchement
1.2.4.2. Vitesses de balayage	1 s/div ... 50 ns/div	en 23 positions étalonnées (progression 1-2-5) Commande continue non-étalonnée 1 : ⩾ 2,5 entre les échelons par potentiomètre
1.2.4.3. Précision de mesure	±2 % ±3 %	entre +20 °C et +30 °C entre + 5 °C et +40 °C Cette précision de balayage, mesurée toutes les deux divisions sur 10 Div est de ±5 % à l'exclusion des premières et dernières divisions sur les positions 5 ns et 10 ns.

Désignation	Spécification	Information supplémentaire
1.2.4.4. Expansion de la vitesse de balayage		
Agrandissement	10x	commutable et étalonné
Erreur supplémentaire	±1 % 5 ns/div	Premières et dernières 50 ns de 5 ns, 10 ns et 20 ns agrandis sont exclues
1.2.4.5. Temps de blocage variable (hold off)	Le temps de blocage du balayage peut être augmenté par un facteur 10 environ	
1.2.5. BASE DE TEMPS RETARDEE		
1.2.5.1. Fonctionnement	La base de temps retardée est déclenchée par la base de temps principale immédiatement après le temps de retard choisi ou par le signal à examiner après le temps de retard (absence de jitter)	
1.2.5.2. Vitesses de balayage	0,5 s/DIV ... 50 ns/DIV	en 22 positions étalonnées (progression 1-2-5) Commande continue non-étalonnée 1 : ⩾ 2,5 entre les échelons par potentiomètre
1.2.5.3. Précision de mesure	±2 % ±3 %	entre +20 °C et +30 °C entre + 5 °C et +40 °C Cette précision de balayage, mesurée toutes les deux divisions sur 10 DIV est de 5 %, à l'exclusion des premières et dernières divisions sur les positions 5 ns et 10 ns.
1.2.5.4. Retard	Continuellement variable entre 0x et 10x le coefficient de temps de la base de temps principale	Etalonné dans le type standard PM 3260. Gamme de multiplicateur du temps de retard 0,00 - 9,99. Précision différentielle 0,5 %, typique 0,2 % Non-étalonné dans le type PM 3260E.
1.2.5.5. Instabilité du retard	< 1 : 20 000	Valeur typique 1 : 30 000
1.2.6. DEVIATION X		
Déviation X par Y_A		
1.2.6.1. Coefficient de déviation	5 mV/DIV à 2 V/DIV	Commande continue non-étalonnée ⩾ 3 : 1 par potentiomètre X AMPL.
1.2.6.2. Erreur de mesure	±5 %	
1.2.6.3. Bande passante	0 ... 2 MHz	–3 dB sur 8 DIV
1.2.6.4. Impédance d'entrée	1 MOhm//15 pF	
1.2.6.5. Déphasage	3° à 100 kHz	
Déviation externe X par douille EXT		
1.2.6.6. Coefficient de déviation	300 mV/DIV	Une position calibrée Commande continue non-étalonnée ⩾ 3 :1 par potentiomètre
1.2.6.7. Bande passante	0 à 2 MHz	–3 dB sur 8 DIV
1.2.6.8. Caractéristiques d'entrée	mêmes que pour voies Y	
1.2.6.9. Déphasage	3° à 100 kHz	

Désignation	Spécification	Information supplémentaire
Déviation X avec tension interne à la fréquence secteur		
La déviation dépend de la tension secteur et est réglée à l'usine sur 8 DIV pour tension secteur 220 V.		
1.2.7. DECLENCHEMENT DE LA BASE DE TEMPS PRINCIPALE		
1.2.7.1. Source	Interne à partir de la voie A Interne à partir de la voie B Interne à partir du secteur Source externe	
1.2.7.2. Mode	Automatique	Fonctionnement automatique du générateur de base de temps environ 100 ms après la disparition du signal de déclenchement
	Levier manuel Balayage simple	
1.2.7.3. Polarité	+ ou −	
1.2.7.4. Sensibilité	Interne ⩽ 0,5 DIV Externe ⩽ 150 mV	Valeur typique en fonction de la fréquence, voir Fig. 1.3
1.2.7.5. Bande passante du filtre	DC: 0 - 120 MHz	Réponse uniforme, en interne et en externe
	LF: 0 - 30 kHz	−3 dB, interne
	LF: 10 Hz - 30 kHz	−3 dB, externe
	HF: 30 kHz - 120 MHz	−3 dB, interne et externe
1.2.7.6. Gamme de niveau	24 DIV −3,6 V à +3,6 V	Déclenchement interne Déclenchement externe
1.2.7.7. Caractéristiques d'entrée	Identique aux voies Y	
1.2.8. DECLENCHEMENT DE LA BASE DE TEMPS RETARDEE		
1.2.8.1. Source	Interne à partir de la voie A Interne à partir de la voie B Externe	
Les autres caractéristiques sont identiques à celles mentionnées au paragraphe 1.2.7. DECLENCHEMENT DE LA BASE DE TEMPS PRINCIPALE.		
1.2.9. UNITE D'ETALONNAGE		
1.2.9.1. Tension de sortie	3 V_{cc}	
1.2.9.2. Courant de sortie	6 mA	
1.2.9.3. Erreur limite	±1 %	Tension et courant
1.2.9.4. Fréquence	2 kHz ± 2 %	
1.2.9.5. Protection	La sortie est protégée contre des courts-circuits même continus.	
1.2.10. ALIMENTATION		
1.2.10.1. Tensions secteur	Toute tension comprise entre 100 et 240 V ±10 %	
1.2.10.2. Fréquence secteur	46 à 440 Hz	
1.2.10.3. Alimentation de sonde	+ et −24 V	sauf dans le type PM 3260E
1.2.10.4. Consommation	45 W	

Désignation	Spécification	Information supplémentaire
1.2.11. POSSIBILITES D'APPLICATION EN RAPPORT AVEC L'ENVIRONNEMENT		
1.2.11.1. Température ambiante	+5 °C ... +40 °C	Gamme nominale d'utilisation
	−10 °C ... +55 °C	Gamme limite de fonctionnement
	−40 °C ... +70 °C	Gamme d'emmagasinage et de transport
1.2.11.2. Altitude	5 000 m	Fonctionnement
	15 000 m	A l'arrêt
1.2.11.3. Humidité	L'appareil répond aux normes IEC 50 B (CO) 142	
1.2.11.4. Choc	L'appareil répond aux normes IEC 68 Eb	
1.2.11.5. Vibration	L'appareil répond aux normes IEC 68 F	
1.2.11.6. Temps de rétablissement	15 minutes (en fonctionnement normal)	quand l'appareil passe de −10 °C à +20 °C à 60 % d'humidité relative
1.2.12. CARACTERISTIQUES MECANIQUES		
1.2.12.1. Dimensions	Longueur 410 mm	Non compris commandes, couvercle et pieds
	Largeur 316 mm	
	Hauteur 154 mm	
1.2.12.2. Poids	9,3 kg	

1.2.13. ACCESSOIRES

1.2.13.1. Accessoires livrés avec l'appareil

Filtres de contraste
Couvercle frontal avec emplacements pour accessoires
Visière pliante PM 9366
Adaptateur BNC banane PM 9051
Borne CAL - Adaptateur BNC
Notice d'emploi et d'entretien
(Notice d'emploi en Francais, Notice de service en Anglais)

1.2.13.2. Accessoires en option

PM 9355	Sonde passive 1:1
PM 9351	Sonde passive 10:1
PM 9358	Sonde passive 100:1 haute tension
PM 9347*)	Sonde t.v. active
PM 9352*)	Sonde active miniature
PM 9353*)	Sonde F.E.T. active
PM 8960	Adaptateur pour montage en rack
PM 8971	Adaptateur de camera
PM 9380	Appareil de photographie d'oscillogrammes Gamme d'appareils Steinheil Oscillophot

*) L'alimentation pour sonde active PM 9346 est nécessaire lorsque ces sondes sont utilisées avec un oscilloscope du type PM 3260E.

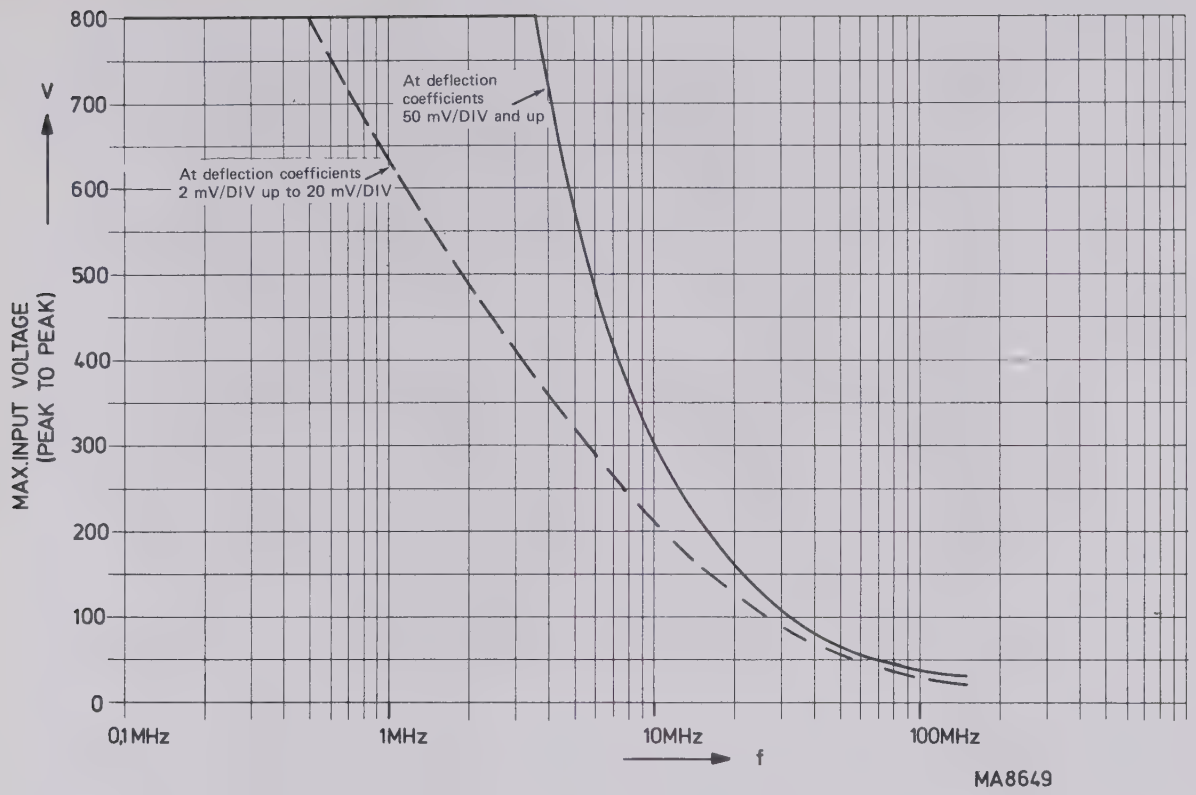

Fig. 1.2. Réduction de la tension d'entrée maximale admise

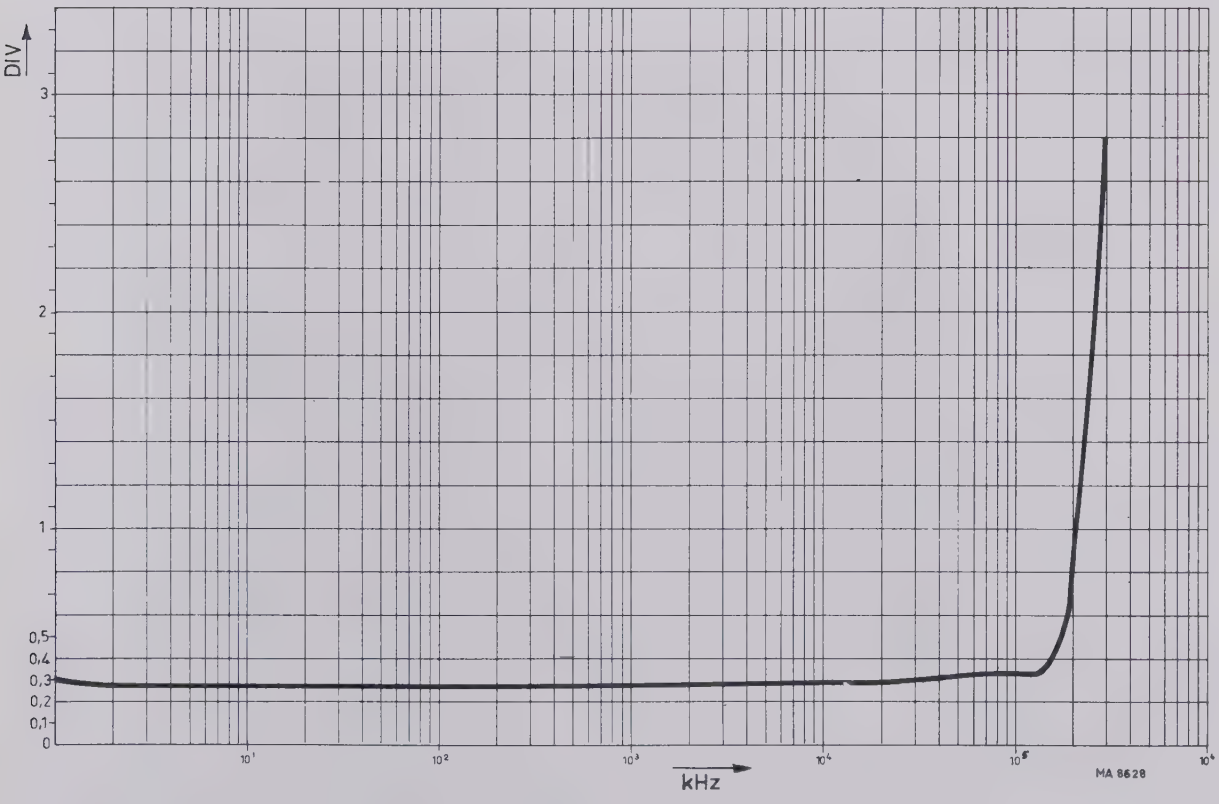

Fig. 1.3. Sensibilités typiques pour déclenchement interne et externe à partir de la voie A

Fig. 2.1. Dépose du couvercle frontal

Fig. 2.2. Vue arrière de l'appareil

2. Mode d'emploi

2.1. INSTALLATION

2.1.1. Démontage et montage du couvercle frontal

Démontage:
- Tourner le bouton au centre du couvercle d'un quart de tour vers la gauche (position UNLOCKED)
- Enlever le couvercle

Montage:
- Tourner le bouton de verrouillage vers position UNLOCKED
- Fixer le couvercle sur la partie avant de l'oscilloscope
- Enfoncer le bouton et le tourner d'un quart de tour vers la droite (position LOCKED).

Remarque: Pour faire pivoter la poignée, il faut enfoncer les boutons-poussoirs aux étriers.

Attention: Le présent appareil produit des tensions élevées et ne peut donc pas être utilisé avec les plaques du châssis déposées. La fiche secteur doit être enlevée et tous les points haute tension déchargés avant de procéder à n'importe quel travail d'entretien.

2.1.2. Adaptation à la tension secteur et fusible

La capacité d'utilisation à toute tension secteur comprise entre 90 et 264 V alternatif supprime la nécessité d'adapter le PM 3260 à la tension secteur locale.
La porte-fusible monté sur le panneau arrière porte un fusible à action retardée de 2 A. L'utilisation de fusibles réparés et le court-circuitage de porte-fusibles sont vivement déconseillés.

2.1.3. Mise à la terre

A des fins de sécurité l'oscilloscope doit être mis à la terre par l'intermédiaire de la borne prévue à cet effet située à l'arrière de l'appareil (reconnaissable au symbole ⏚) ou par l'intermédiaire du câble secteur, à condition que la fiche soit munie d'une connexion de terre.
Il faut veiller à ce que le conducteur de terre ne soit pas interrompu par l'usage d'un câble ou d'une unité de prolongement non-connectés à un conducteur de terre.

2.1.4. Enclenchement

Le commutateur POWER est incorporé dans la commande d'illumination de graticule ILLUM (panneau avant), juste sous le bord de l'écran.
L'oscilloscope ne doit jamais être enclenché lorsqu'une platine ou un bloc a été enlevé. Ne déposer de platine ou de bloc qu'une minute au moins après la mise hors service de l'oscilloscope.

2.2. UTILISATION

Avant d'enclencher, l'appareil, s'assurer qu'il est installé conformément à la section 2.1. INSTALLATION et que les précautions requises ont êtê prises.

2.2.1. Commandes et prises (Fig. 2.3.)

2.2.1.1. Voies verticales

A/ALT/CHOP/ADD/B	Commandes du mode d'affichage; sélecteur à 5 boutons-poussoirs
poussoir A enfoncé	La déviation verticale est obtenue seulement par le signal appliqué à l'entrée de la voie A.
poussoir ALT enfoncé	L'affichage est permuté d'une voie verticale à l'autre, et ce à la fin de chaque cycle du signal de base de temps.
poussoir CHOP enfoncé	L'affichage est permuté d'une voie verticale à l'autre à une fréquence fixe.
poussoir ADD enfoncé	La déviation verticale est obtenue par la somme des signaux A et B.
poussoir B enfoncé	La déviation verticale est obtenue seulement par le signal appliqué à l'entrée de la voie B. Si aucun bouton-poussoir n'est enfoncé, l'appareil fonctionne en mode ALT
POSITION	Commande continuellement variable pour le positionnement vertical des traces.
NORM/INVERT	Commutateur à 2 boutons-poussoirs pour l'inversion de la polarité de signal d'entrée sur l'écran. Si aucun bouton-poussoir n'est enfoncé, on obtient le même effet que si le bouton NORM était enfoncé.
AMPL.	Commutateur à 9 positions des coefficients de déviation verticale.
AMPL./CAL.	Commande continuellement variable des coefficients de déviation verticale. En position CAL. le coefficient de déviation est étalonné.
BAL (accessible par tournevis)	Commande continuellement variable pour l'équilibrage en tension continue des amplificateurs verticaux.
GAIN (accessible par tournevis)	Commande continuellement variable du gain des voies verticales.
AC/0/DC	Mode de couplage du signal d'entrée; commutateur à trois boutons-poussoirs.
AC enfoncé	Couplage par l'intermédiaire d'un condensateur de liaison.
0 enfoncé	La connexion entre l'entrée de l'amplificateur et la prise d'entrée est interrompue et l'entrée de l'amplificateur est mise à la terre.
DC enfoncé	Couplage direct Si aucun bouton n'est enfoncé, on obtient le même effet que lorsque le bouton AC est enfoncé.
A 1 MOhm - 15 pF	Prise d'entrée BNC pour voie A
B 1 MOhm - 15 pF	Prise d'entrée BNC pour voie B

2.2.1.2. Voie horizontale

DEL'D TB - EXT. X DEFL - MAIN TB	Commandes de la déviation horizontale; par commutateur à 3 boutons-poussoirs
poussoir DEL'D TB enfoncé	La déviation horizontale est fournie par le générateur de base de temps retardée.
poussoir EXT. X DEFL enfoncé	La déviation horizontale peut être obtenue par un signal d'origine extérieure appliqué à la prise d'entrée de l'amplificateur horizontal, par le signal de voie A, par le signal de voie B ou par un signal à la fréquence du secteur.

poussoir MAIN TB enfoncé	La tension de déviation horizontale est fournie par le générateur de base de temps principale. Une partie de la trace est intensifiée (sauf en position OFF du commutateur TIME/DIV du générateur de base de temps retardée). Si aucun bouton n'est enfoncé, on obtient le même effet que lorsque le bouton MAIN TB est enfoncé.
POSITION TB MAGN	Commande continuellement variable pour le positionnement horizontal des traces; cette commande comprend un commutateur push-pull qui augmente le coefficient de déviation horizontale d'un facteur 10. Une lampe témoin indiquée x10 s'allume lorsque cette loupe est utilisée.
X AMPL/HOLD OFF	Commande continuellement variable des coefficients de déviation horizontale dans le cas de déviation par un signal extérieur. Dans le cas de déviation X par la base de temps principale, cette commande peut être utilisée pour augmenter le temps de blocage du balayage.

2.2.1.3. Générateur de base de temps principale

LEVEL SLOPE	Commande continuellement variable pour sélectionner le niveau du signal de déclenchement, auquel le générateur de base de temps principale démarre. Cette commande comprend un commutateur push-pull, qui permet de déclencher sur le front positif ou négatif du signal de déclenchement.
NOT TRIG'D	Lampe témoin qui s'allume lorsque le générateur de base de temps principale est en position d'attente.
AUTO - TRIG - SINGLE	Commande de mode de déclenchement; commutateur à trois boutons-poussoirs.
poussoir AUTO enfoncé	Le générateur de base de temps principale est en fonctionnement libre en l'absence de signaux de déclenchement.
poussoir TRIG enfoncé	Le générateur de base de temps est déclenché normalement.
poussoir SINGLE enfoncé	Le générateur de base de temps ne démarre qu'une seule fois à la réception d'une impulsion de déclenchement. Si aucun bouton n'est enfoncé, l'appareil fonctionne en mode SINGLE.

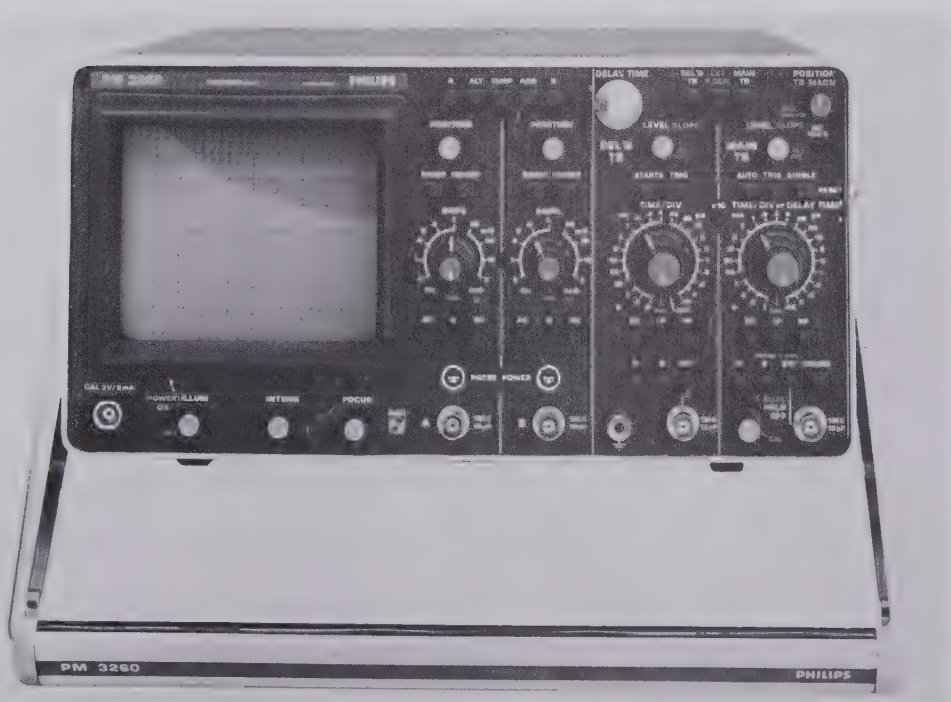

Fig. 2.3. Vue avant de l'appareil

TIME/DIV or DELAY TIME	Commande de la vitesse de balayage de la base de temps principale; commutateur rotatif à 23 positions.
TIME/DIV - CAL (bleu)	Commande continuellement variable de la vitesse de balayage de la base de temps principale. (En position CAL, la vitesse de balayage est étalonnées).
DC - LF - HF	Choix du couplage de déclenchement: commutateur à 3 positions
DC	Les signaux de déclenchement sont couplés directement.
LF	Couplage par le filtre passe-bas pour des fréquences allant jusqu'à 30 kHz (de 10 Hz à 30 kHz pour déclenchement externe).
HF	Couplage par un filtre passe-haut pour des fréquences supérieures à 30 kHz. Si aucun bouton-poussoir n'est enfoncé, on obtient le même effet que si la touche DC était enfoncée.
TRIG ou X DEFL	Commutateur à 4 boutons-poussoirs qui permet de sélectionner ou la source de déclenchement ou la déviation X par une source extérieure
poussoir A enfoncé	Signal de déclenchement interne ou de déviation X provenant de la voie A.
poussoir B enfoncé	Signal de déclenchement interne ou signal de déviation X provenant de la voie B.
poussoir EXT enfoncé	Déclenchement par un signal externe appliqué à la prise adjacente 1 MOhm - 15 pF. Lorsque le bouton EXT X DEFL des commandes de déviation horizontale est enfoncé, cette prise est connectée à l'entrée de l'amplificateur horizontal.
MAINS	Signal de déclenchement ou de déviation X provenant d'une tension interne à la fréquence du secteur. Si aucun bouton-poussoir n'est enfoncé, on obtient le même effet que si le bouton A était enfoncé.
1 MOhm - 15 pF	Prise BNC pour déclenchement externe ou déviation horizontale.

2.2.1.4. Générateur de base de temps retardée

DELAY TIME MULTIPLIER	Commande continuellement variable du temps de retard, utilisée en association avec les commandes TIME/DIV du générateur de base de temps principale.
LEVEL SLOPE	Commande continuellement variable qui permet de sélectionner le niveau du signal de déclenchement auquel le générateur de base de temps retardée démarre. Cette commande comprend un commutateur push-pull qui permet de démarrer sur le front positif ou négatif du signal de déclenchement.
STARTS - TRIG	Sélection du point de départ du générateur de base de temps retardée après le temps de retard; bouton-poussoir à deux positions.
STARTS	Le générateur de base de temps retardée est démarré immédiatement après le temps de retard.
TRIG	Le générateur de base de temps retardée ne démarre qu'après le temps de retard que lorsqu'elle reçoit une impulsion de déclenchement. Si aucun bouton-poussoir n'est enfoncé, on obtient le même effet que si la bouton STARTS était enfoncé.
TIME/DIV	Commande du coefficient de temps pour base de temps retardée; commutateur rotatif à 23 positions. Comprend une position OFF, grâce à laquelle le générateur de base de temps retardée est déclenché.
TIME/DIV - CAL (bleu)	Commande continuellement variable du coefficient de temps de la base de temps retardée. En position CAL, le coefficient de temps du commutateur est étalonné.
DC - LF - HF	Couplage de déclenchement; commutateur à 3 boutons-poussoirs.

DC	Les signaux de déclenchement sont couplés directement.
LF	Couplage par un filtre passe-bas pour les fréquences jusqu'à 30 kHz (pour le déclenchement par un signal exterieur, le filtre passe-bas agit de 10 Hz à 30 kHz)
HF	Couplage par un filtre passe-haut pour fréquences supérieure à 30 kHz. Si aucun bouton n'est enfoncé, on obtient le même effet que si le bouton DC était enfoncé.
A - B - EXT	Commande de la source de déclenchement; commutateur à 3 boutons-poussoirs.
A	Signal de déclenchement interne prélevé de la voie A
B	Signal de déclenchement interne prélevé de la voie B
EXT	Déclenchement par application d'un signal externe à la douille adjacente 1 MOhm - 15 pF. Si aucun bouton n'est enfoncé, on obtient le même effet que si le bouton A était enfoncé.
1 MOhm - 15 pF	Prise d'entrée BNC pour le signal de déclenchement externe.

2.2.1.5. Tube à rayons cathodiques

ILLUM POWER	Commande continuellement variable de l'illumination de graticule; comprend le commutateur secteur. La lampe témoin indique la position ON.
INTENS	Commande continuellement variable pour la brillance de la trace.
FOCUS	Commande continuellement variable pour la focalisation du faisceau.

2.2.1.6. Divers

CAL	Prise de sortie sur laquelle une tension rectangulaire de 3 V_{cc} et un courant de 6 mA sont disponibles à une fréquence de 2 kHz. Précision d'amplitude: ±1 % Précision de fréquence: ±2 % La sortie est protégée contre les courts-circuits continus.
PROBE POWER	Prises pour alimentation d'accessoires actifs; tension délivrée +24 V et −24 V.
⏚	Douille de terre de mesure

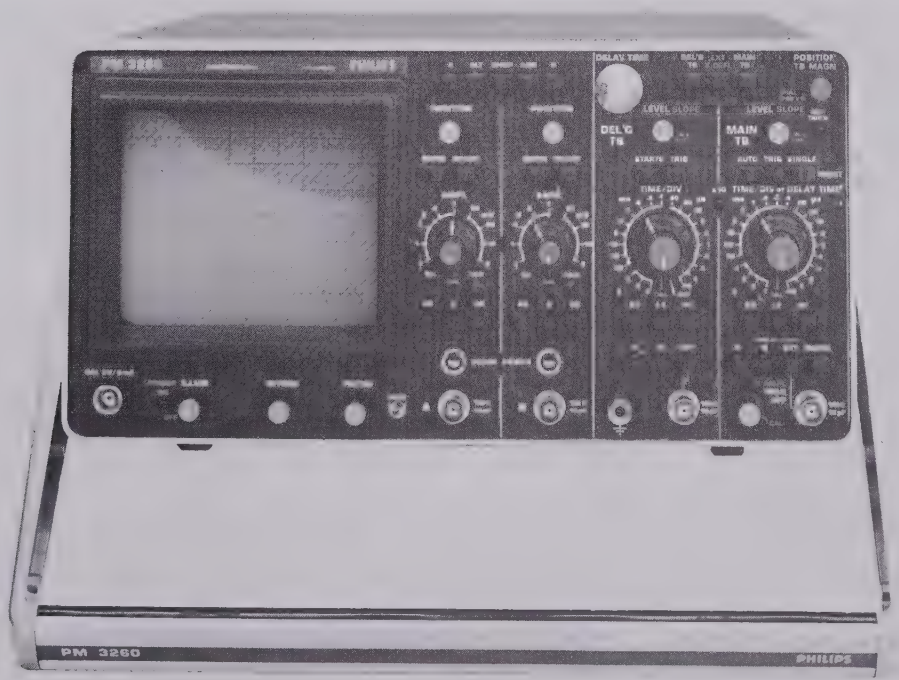

Fig. 2.3. Vue avant de l'appareil

2.2.2. Réglages préliminaires

Etant donné que les réglages suivants sont identiques pour les deux voies verticales, seul le processus pour la voie A est décrit.

2.2.2.1. Réglage de la balance continue

- Actionner le bouton-poussoir A des commandes de mode d'affichage.
- Actionner le bouton-poussoir AUTO des commandes de mode de déclenchement.
- Actionner le bouton-poussoir MAIN TB des commandes de déviation horizontale.
- Régler le commutateur AMPL sur 5 mV et la commande continue sur CAL (étalonnée).
- Centrer la trace avec la commande POSITION.
- Régler les commandes INTENS et FOCUS afin d'obtenir une trace nette et fine.
  Les commandes non-mentionnées peuvent occuper n'importe quelle position.
- Vérifier si la trace ne saute pas lorsque le commutateur AMPL est commuté entre les positions 5 et 10 mV.
  Au besoin, rajuster la commande BAL sur le panneau avant placée immédiatement sous la commande AMPL.

2.2.2.2. Réglage du gain

Sauf indications contraires, les commandes occupent la même position que pour le processus de réglage précédent.
- Régler le commutateur AC-0-DC sur DC.
- Régler le commutateur AMPL sur .5 V et la commande continue sur CAL (étalonnée).
- Connecter la prise d'étalonnage CAL à la prise d'entrée A.
- Vérifier si la hauteur de trace est exactement de 6 divisions.
  Au besoin, rajuster la commande GAIN sur le panneau avant, juste sous le commutateur AMPL.

2.2.3. Entrées A et B et leurs possibilités

L'oscilloscope est pourvu de deux voies identiques, toutes deux pouvant être utilisées soit pour des mesures YT avec un ou deux générateurs de base de temps, soit pour des mesures XY avec la voie horizontale externe.

2.2.3.1. Mesures YT

Pour afficher un signal d'une des voies verticales, il suffit d'actionner le bouton-poussoir A ou B des commandes de mode d'affichage.
Lorsque le bouton-poussoir ALT ou CHOP est enfoncé, deux signaux différentes peuvent être affichés simultanément. Le coefficient de déviation Y et la polarité peuvent être sélectionnées pour chaque voie séparément. Lorsque le bouton ALT est actionné, l'affichage est commuté d'une voie à l'autre au retour du signal de base de temps.
Quoique le mode ALTERNATE puisse être utilisé à toutes les vitesses de balayage du générateur de base de temps, le mode CHOPPED donne une meilleure qualité d'affichage pour des vitesses de balayage lents en effet pendant les temps de balayage longs, l'affichage alterné des deux signaux d'entrée est visible.

En mode CHOPPED, l'affichage est permuté d'une voie à l'autre à une fréquence fixe.
Si le bouton-poussoir ADDED du commutateur de mode d'affichage est actionné, les signaux des deux voies verticales sont additionnées. En fonction des positions des commutateurs de polarité, la somme ou la différence des signaux d'entrée est affichée. Le mode ADDED permet également des mesures différentielles.
Lorsque les commutateurs de polarité des deux voies sont mis en positions opposées, les parties mode commun des signaux aux prises A et B subissent une très légère amplification par rapport aux parties de mode différentiel.

2.2.3.2. Mesures XY

Si les boutons-poussoirs EXT X DEFL des commandes de déviation horizontale et A des commandes TRIG OR X DEFL sont actionnés, les générateurs de base de temps sont déconnectés. Un signal appliqué à la voie verticale A est alors utilisé pour la déviation horizontale. Le commutateur AC/0/DC et l'atténuateur par échelons de la voie A restent en service. La commande continue des coefficients de déviation est possible avec la commande X DEFL/HOLD OFF et le décadrage de la trace horizontale avec la commande X POSITION.

La voie verticale B peut également être utilisée pour la déviation X pour ce faire, le bouton B des commandes TRIG OR X DEFL doit être enfoncé.
Pour la déviation X, il est également possible d'utiliser une tension interne à la fréquence du secteur ou un signal extérieur appliqué à la douille EXT située sur la partie inférieure droite du panneau avant ceci, après avoir enfoncé le bouton-poussoir correspondant des commandes TRIG OR X DEFL. Dans ces modes la largeur de trace peut être commandée avec le potentiomètre X DEFL/HOLD OFF. Lorsque ce potentiomètre est en position CAL, le coefficient de déviation pour un signal extérieur est de 300 mV/DIV.

2.2.3.3. Commutateur AC/0/DC

Les signaux observés sont appliqués aux prises d'entrées A et/ou B et le commutateur AC/0/DC est réglé soit sur AC soit sur DC en fonction de la composition du signal. Du fait que l'amplificateur vertical est couplé directement, tout la bande passante de l'appareil est disponible et le composantes continues sont affichées comme des décalages de trace en position DC du commutateur AC/0/DC. Ceci peut ne pas convenir lorsque de petits signaux superposés à des tensions continues doivent être représentés. Chaque atténuation du signal résulte en une atténuation de la petite composante alternative.
Le remède à cet état est d'utiliser la position AC du commutateur d'entrée, lequel comprend un condensateur de liaison servant à supprimer les signaux continus et basse fréquence. Lorsque des signaux rectangulaires à basse fréquence sont représentés, on obtient une certaine pente de toit.

En position 0 le signal est interrompu et l'entrée de l'amplificateur est mise à la terre, sur cette position, le niveau 0 V est rapidement déterminé.

2.2.4. Déclenchement

Lorsqu'un signal doit être représenté, la déviation horizontale doit toujours être démarrée à un point fixe du signal, et ce afin d'obtenir une trace stationnaire. Le générateur de base de temps est donc démarré par des impulsions de déclenchement étroites produites dans l'unité de déclenchement et commandé par un signal qui peut provenir: d'un des signaux appliques aux entrées verticales, d'une tension interne à la fréquence du secteur, ou une source extérieur.

2.2.4.1. Couplage de déclenchement

Trois méthodes de couplage de déclenchement sont possibles avec le commutateur DC/LF/HF. En positions HF et LF, la caractéristique de transfert est limitée.
En position DC, le signal de déclenchement reste inchangé.
En position LF, un filtre passe-bande de 0 Hz (10 Hz pour déclenchement externe) à 30 kHz est incorporé.
Cette position peut être utilisée pour réduire l'interférence du bruit.
En position HF, un filtre passe-haut de 30 kHz est incorporé.
Cette position peut être utilisée pour réduire l'interférence du ronflement par exemple.

2.2.4.2. Sélection de la source de déclenchement et réglage du niveau de déclenchement

Le signal de déclenchement est obtenu à partir de la voie A (bouton A enfoncé), de la voie B (bouton B enfoncé), d'une source externe (bouton EXT enfoncé) ou d'une tension interne à la fréquence du secteur (bouton MAINS enfoncé).
Le conformateur d'impulsions de déclenchement est un multivibrateur à double commande commuté par les signaux de sortie d'un amplificateur différentiel.
Le signal de déclenchement, sur lequel la commande continue AMPL n'a pas d'effet, est appliqué aux entrées de l'amplificateur différentiel de concert avec les tensions continues réglables avec le potentiomètre LEVEL.
En fonction du réglage LEVEL, une certaine partie du signal de déclenchement est amplifiée par l'amplificateur différentiel.
Le multivibrateur est donc commuté à un point fixe du signal de déclenchement (voir Fig. 2.4.). Ceci signifie que, s'aidant de la commande LEVEL, il est possible de donner sa forme au signal de déclenchement (en cas de déclenchement interne A ou B égal à la forme du signal à représenter) et donc, de choisir le point où le multivibrateur sera commuté.
Le potentiomètre LEVEL est pourvu d'un commutateur push-pull qui permet la sélection de la pente de déclenchement.

2.2.4.3. Déclenchement automatique

Lorsque le bouton AUTO du commutateur AUTO - TRIG - SINGLE est enfoncé, et qu'aucune impulsion de déclenchement n'est disponible, le générateur de base de temps fonctionne librement.
La trace est alors toujours visible. Le mode AUTO peut être utilisé dans tous les cas où le mode TRIG est également applicable, à l'exception de signaux dont la fréquence est inférieure à 10 Hz et des trains d'impulsions ayant un temps supérieur à 100 ms.
Dès que des impulsions de déclenchement sont disponibles, le fonctionnement libre du générateur de base de temps est automatiquement achevé et le générateur est à nouveau déclenché comme décrit aux paragraphes 2.2.4.1. et 2.2.4.2.
Lorsque les boutons TRIG ou SINGLE sont actionnés, le circuit automatique est mis hors circuit. Le réglage LEVEL peut également être utilisé en mode AUTO.

2.2.4.4. Déclenchement du balayage en SINGLE

Lorsque des effets uniques sont observés (par photographie), il faut s'assurer qu'une seule dent de scie est engendrée, même si plusieurs impulsions de déclenchement doivent être produites après le phénomène en question. Il va de soi que la dent de scie simple en question doit être déclenchée par une impulsion de déclenchement. Pour ce faire, le bouton SINGLE doit être enfoncé. La première impulsion de déclenchement apparaissant après le relâchement du bouton démarre le générateur de base de temps, celui ci est alors bloqué jusqu'à ce que le bouton SINGLE soit enfoncé à nouveau. La lampe NOT TRIG'D s'allume dès que le bouton SINGLE est relâché, et ce jusqu'à la fin de la dent de scie.

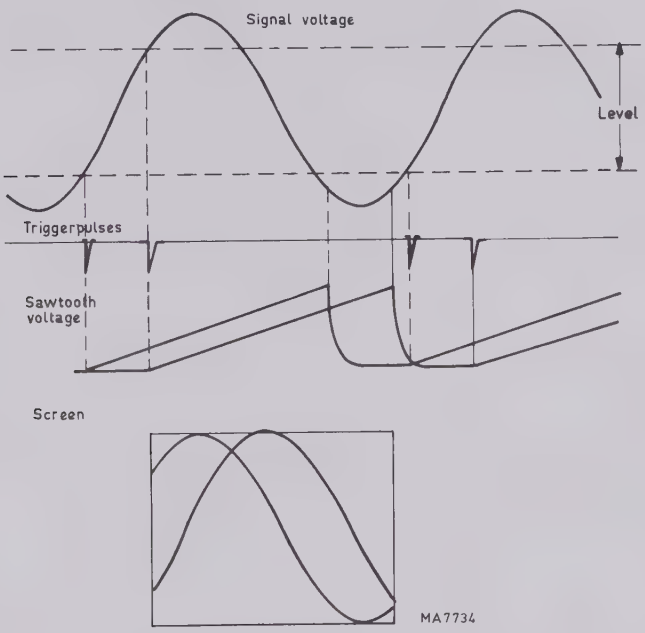

Fig. 2.4. Analyse de la forme d'onde à l'aide du potentiomètre LEVEL

2.2.5. Agrandisseur de base de temps MAGN

L'agrandisseur de base de temps est actionné par un commutateur push-pull à deux positions incorporé dans la commande POSITION horizontale. Lorsque ce commutateur est tiré en position x10, les vitesses de balayage du générateur de base de temps principale sont augmentées d'un facteur 10. Donc, en x1, (TB MAGN enfoncé) la portion du signal affichée sur une largeur égale à une division au centre de l'écran occupe la largeur totale de l'écran en position x10. Chaque portion de la trace peut être rapportée sur l'écran à l'aide de la commande de POSITION horizontale.
En position x10, le coefficient de temps est déterminé en divisant par 10 la valeur TIME/DIV.
Un voyant lumineux rouge indique à l'opérateur qu'il utilise la position x10.

2.2.6. Utilisation de la base de temps retardée

La base de temps retardée peut être utilisée pour l'étude précise de signaux complexes. Lorsque le bouton-poussoir STARTS de la commande STARTS/TRIG est actionné, la base de temps retardée est immédiatement enclenchée (le commutateur TIME/DIV n'est pas sur OFF) et une portion du signal affiché est intensifiée en position MAIN TB des commandes de déviation horizontale. La commande DELAY TIME permet de décaler cette partie intensifiée le long de l'axe des temps. La durée de cette portion intensifiée ainsi que sa longueur peuvent être commandées par échelons et ce de façon continue à l'aide des commandes TIME/DIV du générateur de base de temps retardée. Lorsque le bouton-poussoir DEL'D TB des commandes de déviation horizontale est enfoncé, la portion intensifiée occupe la largeur totale de l'écran. En position DEL'D TB, le retard (c.à.d., l'intervalle entre le point de démarrage de la base de temps principale et le point de démarrage de la base de temps retardée) est déterminé par les réglages des commandes TIME/DIV principales et de la commande DELAY TIME.

Lorsque le bouton TRIG de la commande STARTS/TRIG est enfoncé, la base de temps retardée est démarrée par la première impulsion de déclenchement qui apparaît après le retard sélectionné. Cette impulsion de déclenchement est produite par l'impulsion de déclenchement du générateur de base de temps retardée. Cette position est utilisée pour éviter une instabilité de la base de temps, laquelle donne une représentation floue d'un détail. Cette instabilité peut faire partie du signal à analyser ou, pour des agrandissements extrêmes, être produite dans les circuits de base de temps.

Service manual

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3. Service manual

3.1. DESCRIPTION OF THE BLOCK DIAGRAM

3.1.1. General information

The PM 3260 oscilloscope comprises the following parts:
- a dual-channel vertical system
- a main time-base
- a delayed time-base
- a switching unit
- an X amplifier
- a Z amplifier
- a c.r.t. circuit
- a stabilized power supply

3.1.2. Dual-channel vertical system

Both vertical channels contain identical circuits. An input signal to one of the channels is, via a coupling switch AC/0/DC, applied to the input attenuator. In the AC position of the coupling switch there is a capacitor in the signal path. In the DC position the coupling is direct.
If the coupling switch is set to the 0 position, the connection between the input socket and the attenuator input is interrupted, the latter being earthed.

The input attenuator, which is controlled by the AMPL switch, enables the adjustment of the vertical-deflection sensitivity in calibrated steps.

The attenuator is followed by a low-drift impedance converter which gives the input circuit a high input impedance.
The impedance converter also contains a voltage divider which works in conjunction with the input attenuator. The d.c. balance of the entire channel is set by compensating for the d.c. offset voltage of the impedance converter by means of the BAL potentiometer.

The signal that leaves the impedance converter on a 50 Ohm level is applied to a paraphase amplifier where it is transformed into a push-pull signal. The paraphase amplifier has two outputs. From one of these outputs the signal is applied to a trigger pre-amplifier and from the other one to an amplifier stage. This stage comprises the switch NORMAL/INVERT by means of which the phase of the signal can be inverted, and a GAIN pre-set potentiometer which allows the overall gain of the channel to be set.

The following stage is a channel selector which either blocks or passes the signal as dictated by the channel selector logic. The channel selector also comprises the controls for vertical trace positioning.
In the A, B and ADD modes the channel selector logic is set by means of voltage levels and in the ALT and CHOP mode controlled by pulses. In the ALT mode those pulses are supplied by the sweep-gating multivibrator of the main time-base generator during the flyback of the sweep, so that alternately the complete signals of channel A and channel B are displayed.
In the CHOP mode the drive pulses are provided by an oscillator which works at a fixed frequency of approximately 1 MHz.
Those pulses cause the electronic switches in the channel selector to be successively opened and closed so that successively part of the signal of channel A and of channel B are displayed.

After the channel selector, the following circuits are common to both vertical channels.
A delay line that delays the vertical signals to such an extent that the steep leading edges of fast signals are still displayed, a correction circuit in which the losses caused by the delay line are compensated for, and a final output stage which feeds the signals to the vertical-deflection plates.

3.1.3. Time bases

3.1.3.1. Main time-base

The trigger source/X deflection selector receives its signal from one of the vertical channels, from the attenuator/impedance converter for external trigger or X deflection signals, or from the power supply (MAINS). One of those signals can be selected by operating one of the controls incorporated in this stage.

From the selector stage the signal is fed to either the X amplifier for horizontal deflection, or the trigger amplifier for starting the time-base generator. The amplifier is a differential one, containing the controls for trigger-level adjustment, slope selection and coupling selection. By means of the coupling control, the input frequency range of the trigger circuit can be set. The slope selector allows the polarity of the trigger signal to be inverted, enabling triggering on the positive as well as on the negative slope of the input signals.

From the amplifier the trigger signal is applied to the trigger multivibrator that supplies well-defined trigger pulses. These trigger pulses are used to switch the sweep-gating multivibrator and, when the AUTO push-button has been operated, for driving the automatic circuit.

The sweep-gating multivibrator starts and stops the integrator which delivers the sawtooth signal required for the horizontal deflection. The integrator comprises the charging capacitors and resistors selected by the TIME/DIV switch in order to set the time coefficients in calibrated steps. Continuous control of the time coefficients is obtained by varying the charging current of the time determining capacitors by means of the TIME/DIV potentiometer.

The amplified output signal of the integrator is fed to the X deflection selector, the hold-off multivibrator and the comparator which is part of the delayed time-base unit. The hold-off multivibrator switches back the sweep-gating multivibrator and blocks its input during the flyback of the sawtooth signal. The hold-off circuit also incorporates the single-sweep circuit which causes the main time-base to deliver only one sawtooth pulse, after the SINGLE button has been depressed and upon receipt of a trigger pulse.

The automatic free-run circuit or auto-circuit makes the time-base generator free-running when there are no trigger pulses.

3.1.3.2. Delayed time-base

The delayed trigger-unit and time-base generator comprise in principle the same circuitry as the main trigger-unit and time-base generator. The delayed time-base works always in the single-shot mode. It is started by the main-time-base generator which also serves as hold-off circuit for the delayed time-base.

The DELAY TIME MULTIPLIER control, the comparator and the reset multivibrator determine the delay time for the delayed time-base generator. The operating modes of the delayed time-base generator can be selected by means of the STARTS/TRIG switch. If the STARTS push-button is depressed, the delayed time-base generator starts immediately after the delay time. When the TRIG button is operated, however, the delayed time-base is started upon receipt of the first trigger pulse after the delay time.

When push-button MAIN TB of the horizontal deflection mode controls has been depressed, the part of the trace coinciding with the delayed sweep is intensified, except in the OFF position of the delayed TIME/DIV switch.

3.1.4. Switching unit and X amplifier

Apart from the blanking pulse selector and the X deflection selector, the switching unit comprises an amplifier for external X deflection signals and an intermediate amplifier. The X deflection selector couples the external X deflection signal, the output signal of the main time-base generator or the combined output signals of the main and delayed time-base generators to the intermediate X amplifier and from there, via the final amplifier, to the horizontal-deflection plates. The intermediate amplifier comprises the horizontal trace positioning and 10x magnification controls.

The blanking pulse selector supplies blanking pulses to the Z amplifier. These pulses blank the trace at the end of the sweep of the main time-base and provide the extra bright-up pulse if the oscilloscope operates with a portion of the trace intensified. The blanking pulses during the switching of the traces in the chopped mode go direct from the channel selector logic to the Z amplifier.

3.1.5. Z Amplifier and c.r.t. circuit

The Z amplifier receives two input signals. One originates in the time-base generator and is, via the switching circuit, applied to the Z amplifier to blank the trace during the flyback.
The other one is supplied by the channel selector logic to blank the trace during switching from channel to channel in the chopped mode. The INTENS potentiometer determines the amount of input current fed to the Z amplifier. At the output of the amplifier, the signal is split into two parts: an l.f. + d.c. part and an h.f. part. The h.f. part is fed direct to the Wehnelt cylinder of the c.r.t. The l.f. + d.c. part is modulated on to an oscillator signal and afterwards detected in a peak-detector. Both signal parts are combined again on the Wehnelt cylinder.

The focus voltage for the c.r.t. is generated in an oscillator. The output voltage of the oscillator is rectified, multiplied by a factor of 5 and applied to the focussing anode. The focussing voltage is controlled by the FOCUS potentiometer which is electronically coupled with the INTENS potentiometer. In this way, defocussing due to operation of the INTENS potentiometer is largely obviated.

The high voltage for the post-acceleration anode of the c.r.t. is supplied by a stabilized oscillator whose output voltage is rectified and multiplied by a factor of 9.

Furthermore, the c.r.t. circuitry comprises preset potentiometers for trace rotation, astigmatism, distortion and orthogonality.

3.1.6. Stabilized power supply

The mains voltage is full-wave rectified and fed to a voltage regulator.
The rectified mains voltage controls a blocking oscillator which generates a voltage at a frequency of approximately 20 kHz. This voltage is applied to the primary of a transformer.
The secundary voltages of this transformer are full-wave rectified, smoothed and applied to the various circuits.

The MAINS triggering signal is taken direct from the mains and, via an opto-isolator, fed to the trigger circuitry on a safe level.
The calibrator is a square-wave generator which supplies an accurate voltage and current for calibration purposes.

3.2. CIRCUIT DESCRIPTION

3.2.1. Vertical deflection system

3.2.1.1. Input stage

The input stage comprises two identical units: the input attenuators. Each attenuator consists of a triple high-ohmic voltage divider and an impedance converter, the latter being a circuit block. The impedance converter has three outputs at different signal levels.

The total attenuation of the input stage is determined by the combination of the relevant section of the voltage divider and the relevant output of the impedance converter.
Reed relays switch in the various combinations as dictated by the position of the attenuator switch on the front panel.

The high-ohmic voltage divider sections attenuate (from top to bottom in the circuit diagram) 1x, 10x and 100x.
In combination with R112 the attenuation is 1,25x, 12,5x and 125x. Output 2 of the impedance converter gives an attenuation of 1x, output 5 of 2x and output 8 of 4x.
With the combination of the attenuators before and after the impedance converter, nine deflection coefficients from 5 mV/DIV to 2 V/DIV in 1-2-5 sequence are realized.

The input capacitance of the oscilloscope is kept constant for the various attenuator positions by means of trimmers C102, C107 and C111. The high-ohmic voltage divider sections are made independent of the frequency (i.e. the capacitive attenuation for a.c. signals is equalized to the resistive attenuation for d.c. signals) by means of trimmers C101, C108 and C109.

The input source-follower of the impedance converter is protected by diode GR101. If there is a maximum positive-going voltage change, the field-effect transistor can deal with it. If the change goes negative beyond the threshold established by diode GR101, the latter starts conducting and the excess voltage is short-circuited.

The BAL potentiometer, which can be adjusted on the front panel, keeps the input circuit balanced in the various positions of the high-ohmic voltage divider.

The output impedance of the impedance converter is 50 Ohm in all attenuator positions. In this way, a correct match is obtained for the coaxial cable to the intermediate amplifier.

The input attenuators also comprise the input-coupling switches which are operated via reed relays. In the AC position, capacitor C104 is in the circuit, reducing the lower frequency limit to 10 Hz.

3.2.1.2. Intermediate amplifier

The intermediate amplifier consists chiefly of circuit blocks. In this way, a great stability is obtained for temperature, drift and tolerances. As the channel A and channel B signal paths are identical, only the channel A signal path will be described.

The output signal of the channel A input stage is applied to point 12 of circuit block IC352 (AMPLIFIER I), via an emitter follower TS302 which boosts the h.f. part of the signal. This emitter follower is located underneath IC352, at the rear of the circuit board.
Transistors TS351 and TS352 are constant current sources for this circuit block. On points 13 and 15 of the latter, the h.f. response is corrected by means of RC networks with C356, C357, C358 and C359, and R364 and R366. The response to very high frequencies is controlled with potentiometer R368, via point 14 of the circuit block.
Circuit block AMPLIFIER I has two pairs of symmetrical outputs: one to the next amplifier of the Y signal and a second one to the trigger pre-amplifier.

The Y output signal of circuit block IC352 (AMPLIFIER I) is applied to circuit block IC354 (AMPLIFIER II), points 11 and 15. In this amplifier, the overall gain of the channel is adjustable by means of GAIN potentiometer R16, which is connected to point 10 of the AMPLIFIER II block via the continuous control of the Y deflection coefficients R11.

Both potentiometers can be operated on the front panel.
Possible unbalance due to readjustment of the GAIN potentiometer can be compensated for with the GAIN BAL potentiometer R361, which alters the bias of current source TS351 of the AMPLIFIER I circuit block.

To points 7 and 19 of the AMPLIFIER II block, a circuit with transistors TS353, 354 and 356, diode GR351 and integrated circuit IC353 has been connected. IC353 is an operational amplifier.
The circuit, which is controlled by the AMPL potentiometer, sets the gain of AMPLIFIER II by means of a diode bridge between the two balanced signal paths. The dynamic resistance of the diode bridge varies when the AMPL potentiometer is rotated. In this way a smaller or larger part of the symmetrical signal is 'short-circuited'. IC353 gives this control a high stability, by keeping the ratio between the control current of the diodes and the signal current at a constant value.

NORM/INVERT switch SK6 has been connected to points 2 and 24 of the AMPLIFIER II block, via resistors R388 and R389.
This switch allows the Y signal of the A channel to be inverted in polarity. Possible unbalance between the two positions of this switch can be compensated for by means of pre-set potentiometer R383.

The output signal of the AMPLIFIER II block is fed to points 14 and 12 of circuit block IC306 (CHANNEL SELECTOR). In this circuit block, the signals of channels A and B are joined together again, the channel B signals being applied to points 27 and 29. The output signal of the CHANNEL SELECTOR block on points 19 and 22 is connected to delay line L301, via 50 Ohm cables. This output signal can be: the channel A signal only, the channel B signal only and channels A and B added, chopped or alternated, as dictated by the control signal on points 4 and 7 of the CHANNEL SELECTOR block. The control signal originates in the CHANNEL SELECTION LOGIC which is described in section 3.2.1.3.

Point 5 of the CHANNEL SELECTOR block is connected to a supply voltage delivered by emitter follower TS311. If push-button ADDED of the display-mode controls is depressed, this voltage is higher, as both channels are then switched in at the same time.

The position of the displays of both channels is also controlled in the CHANNEL SELECTOR block. The controls are POSITION potentiometers R3 and R7, operated on the front panel of the instrument.

The last circuit block of the intermediate amplifier is IC351 (TRIGGER), the trigger pre-amplifier for channel A. The channel B trigger pre-amplifier is identical TRIGGER block IC301. The input of the TRIGGER block, points 27 and 29, is connected to the symmetrical output of AMPLIFIER I block IC352, points 27 and 29.

The TRIGGER block has two symmetrical outputs. One output, points 12 and 15, is connected to the trigger circuit of the main time-base generator, whereas the other one, points 11 and 14 is connected to the delayed time-base trigger circuit.
The output signals must be symmetrical and on zero-volt levels.
The symmetry can be set by means of potentiometer R351 and the zero-volt level with the aid of potentiometer R354.

3.2.1.3. Channel selection logic

The channel selection logic consists of digital circuits comprising standard dual-in-line integrated circuits IC1601, IC1602 and IC1603. The outputs 3 and 6 of IC1602 are connected to inputs 4 and 7 of CHANNEL SELECTOR block IC306. The logic levels in this digital circuit are: logic '1' is +5 V and logic '0' is 0 V.
If output 6 of IC1602 is high (logic 1), channel A is switched in. The same is true for output 3 of IC1602. If this point is logic 1, channel B is switched in. The levels on outputs 3 and 6 of IC1602 are determined by JK flip-flop IC1603.

In the following we shall discuss the different functions of the logic circuit on the basis of the positions of the display-mode controls.

If SK1 (A) is depressed, channel A only, input 2 of the JK flip-flop is low and consequently its output 6 is high. As a result of this, output 3 of IC1602 is low and channel B is blocked. Output 8 of the JK flip-flop is low and consequently output 6 of IC1602 is high: channel A is switched in.

If SK1 (E) is depressed, channel B only, input 13 of the JK flip-flop is low and consequently its output 8 is high. As a result of this, output 6 of IC1602 is low and channel A is blocked. Output 6 of the JK flip-flop is low and consequently output 3 of IC1602 is high: channel B is switched in.

SK1 (D) depressed: channels A and B added. Then both input 5 and input 2 of IC1602 are low and consequently both output 6 and output 3 are high: both channels are switched in.

SK1 (C) depressed: channels A and B chopped. In this position a chopper generator is switched into the circuit. The generator consists of parts of IC1601. Between points 2 and 3, and 2 and 6 of IC1601, there is a feedback loop.
This means that the circuit starts oscillating when input 1 of IC1601 is high, the oscillation frequency being 2 MHz.

Via points 9 and 8 of IC1602 and 9 and 8 of IC1601, this 2 MHz signal is fed to trigger input 12 of JK flip-flop IC1603. This flip-flop is then set and reset at a frequency of 1 MHz. The 1 MHz output signal appears in turn on inputs 4 and 1 of IC1602. Consequently outputs 3 and 6 of IC1602 are in turns high, thus providing the chopped control signal for the CHANNEL SELECTOR block IC306.

During the switching over in the CHOP mode, the c.r.t. is blanked with the aid of pulses supplied by transistors TS1602 and TS1603. Normally these transistors are always bottomed via resistor R1608. In the CHOP mode, however, the negative-going edges of the 2 MHz chopper signal are differentiated via C1603. As a result, positive pulses arise on the collector of TS1602. These pulses are fed to the Z amplifier via transistor TS1603.

SK1 (B) depressed: channels A and B alternately displayed.
This push-button is a dummy and has no contacts, but it releases all the other push-buttons of the display-mode controls.
In this mode, input 13 of IC1601 carries the collector signal of transistor TS1601. The hold-off pulse of the main time-base generator is fed to the base of this transistor.
During the sweep, this pulse is approximately 0 V and during the hold-off period it is positive. Consequently, the hold-off pulses are present on the collector of TS1601 and, therefore, on input 13 of IC1601. These pulses are, via output 11 of IC1601, fed to input 10 of IC1601. From output 8 of this IC, the inverted signal is applied to trigger input 12 of JK flip-flop IC1603. As a result of this, the flip-flop is set and reset by a signal which is a replica of the main time-base hold-off pulses. Outputs 6 and 3 of IC1602 are in turns high and low and the input signal of the oscilloscope is alternately displayed by channels A and B.

3.2.1.4. Final Y amplifier

The final Y amplifier comprises three circuit blocks IC401, IC402 and IC403 and two output transistors TS401 and TS402. The output signal of the delay line is applied to inputs 18 and 23 of circuit block IC401 (DELAY LINE CORRECTION AMPLIFIER), via 50-Ohm coaxial cables.
As the delay line is a source of distortion for higher frequencies, there is a h.f. correction network included between the delay line and circuit block IC401. This network consists of capacitors C400 ... C407 and resistors R403 ... R407. Correction of the highest frequencies is possible with the aid of varicap diodes which are incorporated in the DELAY LINE CORRECTION AMPLIFIER block. The bias of the varicap diodes is set by means of pre-set potentiometers R409 and R410.

The DELAY LINE CORRECTION AMPLIFIER block is provided with two symmetrical outputs: 12-15 and 11-14. Output 12-15 is connected to input 26-30 of circuit block IC402 (FINAL AMPLIFIER) and output 11-14 is connected to the same input of a similar circuit block IC403 (FINAL AMPLIFIER).

The outputs of the FINAL AMPLIFIER blocks are connected in parallel and symmetrically applied to output transistors TS401 and TS402.
The overall gain of the final amplifier can be set by means of potentiometer R432 which controls the voltage on point 27 of circuit block IC401 (DELAY LINE CORRECTION AMPLIFIER).

The collectors of the output transistors are connected to the Y deflection plates of the c.r.t. Each Y deflection plate consists of four parts which form filters together with coils L401 ... L409 and the stray capacitances of the deflection plates. The constants of this filter network are chosen in such a way that the propagation velocity of a pulse equals the velocity of the electron beam. In this way transit-time distortion is kept to a minimum. The filter chain terminates in resistors R418 ... R431. The termination is optimized by means of potentiometer R423.

3.2.2. Triggering of the main time-base generator

The trigger unit of the main time-base generator has four input sources, viz. an external source, part of the signal of channel A, part of the signal of channel B or the mains. These sources can be used for both triggering and X deflection. Source selection is made with the aid of current sources that drive a symmetrical circuit.

3.2.2.1. Trigger input circuits and amplifier

A signal on EXT trigger socket BU8 is applied to the gate of input field-effect transistor TS601A, via voltage divider R601-R602 and capacitor C610. The gate of the field-effect transistor is protected against overload by means of two sets of two diodes in series, which limit the gate voltage to + and −1,4 V.

With the aid of DC switch SK19 selection is possible between a.c. and d.c. coupling of the input signal. If SK19 is depressed, resistors R606 and R607 bypass capacitor C610 with the result that also d.c. voltages are applied to the gate of field-effect transistor TS601A. Capacitor C607 suppresses possible interference signals that might be picked up by the long lead between switch SK19A on the front panel, and the trigger unit.

In the source circuit of field-effect transistor TS601B, which is connected in series with TS601A, there is a potentiometer R631. This potentiometer allows balancing of the signal for the next amplifier stages.

The output signals of field-effect transistors TS601 are applied to the base of transistor TS608. This transistor is, together with transistor TS604, switched in by current source TS607. The latter is controlled by EXT TRIG switch SK21. If this switch is depressed, current source TS607 causes a 10 mA current to flow through transistors TS604 and TS608 which can then transmit the signals to the trigger amplifier.

The trigger signals from channels A and B are symmetrically applied to similar circuits. For channel A the circuit comprises transistors TS611 and TS613 as gates and transistor TS612 as a current source. The current source is switched in by means of TRIG A switch SK21.
For channel B the gates are transistors TS614 and TS617, the current source being TS616. The current source is switched in by means of TRIG B switch SK21. Both input A and input B are provided with a pre-set potentiometer to adjust the balance of the stage: R636 for channel A and R656 for channel B.

The fourth possible trigger source is the MAINS. The trigger signal is transmitted to the trigger unit via a photo coupler in the power supply and applied 'common mode' to transistors TS623 and TS626. This 'common mode' drive suppresses fast interference signals and high frequencies in the trigger signal. Transistors TS623 and 626 are the gates and transistor TS624 is the current source. The current source is switched in by means of TRIG MAINS switch SK21.
Depending on which push-button of the horizontal deflection controls SK2 is depressed, one of the previously discussed signals is used for either triggering or horizontal deflection. When push-button DEL'D TB or MAIN TB SK2 is depressed, the signal is used for triggering. If, on the other hand, push-button EXT X DEFL SK2 is operated, the signal is fed to the horizontal amplifier on the switching unit. In that case, the signal is picked off from the collector of transistor TS609 which is then switched in, together with transistor TS602, via push-button EXT X DEFL SK2.

If push-button EXT X DEFL SK2 is released, the signal is fed to transistors TS603 and TS618. From these transistors, the signal is applied to that part of the trigger amplifier where the choice is made between h.f., l.f. and d.c. trigger coupling. The choice is made by means of trigger coupling controls SK19.

Push-button LF SK19 depressed: l.f. trigger coupling.
Current source TS628 is switched in. The cathodes of diodes GR603 and GR604 then carry a voltage of approximately +5 V.
Consequently, the signal from the trigger pre-amplifier cannot be transmitted via transistors TS627 and TS633. Instead it is transmitted via the signal path with R681 and R698, amplified by transistors TS629, TS632, TS639, TS637, TS641 and TS636 and applied to the bases of transistors TS642 and TS634. On these points, the trigger signal is integrated with the aid of capacitors C622 and C623 which are at one side connected to the +5 V voltage mentioned above.
Consequently, triggering on the l.f. component of the triggering signal is obtained.

Push-button HF SK19 depressed: h.f. trigger coupling.
Current source TS628 is switched off as push-button LF SK19 is released. Transistors TS629 and TS632 are turned off because their bases are earthed via double diode GR602 and push-button HF SK19. The triggering signal is applied to the bases of transistors TS642 and TS634, via transistors TS627 and TS633 and capacitors C622 and C623. Capacitors C622 and C623 now act as differentiators. Consequently, triggering on the h.f. component of the triggering signal is obtained.

Push-button DC SK19 depressed: d.c. trigger coupling. DC SK19 is a dummy switch which releases push-buttons LF and HF. In the DC position, LF SK19 and HF SK19 are open and, therefore, both the l.f. path and the h.f. path are in operation. Consequently, the entire triggering signal is transmitted. By means of potentiometer R712 in the emitter circuit of TS641 and TS636, the sensitivity of the l.f. path is equalized to that of the h.f. path. Therefore, the d.c. trigger signal will be undistorted.

The trigger level is set by means of LEVEL potentiometer R10 in the base circuit of transistor TS639. The control range of this potentiometer is preset with the aid of potentiometer R709 in the base circuit of transistor TS637.
Via transistors TS642 and TS634, the signal is applied to the push-pull amplifier with transistors TS643-TS646 and TS644-647.
The amplified triggering signal is applied to the trigger pulse shaper.

3.2.2.2. Trigger pulse shaper

The trigger pulse shaper is incorporated in circuit block IC601 (TRIGGER PULSE SHAPER). The input of this circuit block consists of four transistors, two of which are operating at the time. Which two transistors are operating depends on the position of the +/— trigger slope switch SK5, that enables triggering on either the positive- or the negative-going edge of the triggering signal.

The next circuit in the TRIGGER PULSE SHAPER block is the trigger multivibrator, which is switched over by the triggering signal. The resulting square-wave signal is differentiated and sharp trigger spikes are obtained. The negative-going spikes are available on output 16 of the TRIGGER PULSE SHAPER block and from there applied to the sweep-gating multivibrator of the main time-base generator.
The positive-going pulses are available on output 14 and they are used to control the automatic triggering circuit.
Potentiometer R737 which is connected to input 23 of the TRIGGER PULSE SHAPER block, is used to set the trigger slope balance.

3.2.2.3. Auto-circuit

The auto-circuit consists in principle of electrolytic capacitor C643 in parallel with the series circuit of transistors TS648 and TS649. When transistor TS649 receives positive-going trigger pulses from circuit block IC601 (TRIGGER PULSE SHAPER), this transistor starts conducting.
As a result of this, also transistor TS648 starts conducting and capacitor C643 is discharged. The output voltage of the auto-circuit is then approximately −15 V. This voltage is applied to the anode of diode GR803 in the main time-base sweep generator and sets the sweep-gating multivibrator input to such a level that it is driven by the negative-going trigger pulses.

If there are no trigger pulses available, capacitor C643 is no longer short-circuited. The sweep-gating multivibrator input is then set to such a level that initiation of the sweep depends only on the sweep feedback voltage: the main time-base sweep generator is free-running.

3.2.3. Main time-base generator

The main time-base generator comprises a sweep-gating multivibrator TS801-TS802, followed by switching transistors TS807 and TS808 which are in parallel with the time-base capacitors. Transistor TS806 is used as a current source to charge these capacitors. The sawtooth voltage across the time-base capacitors is taken off via transistor TS826 and the left-hand transistor of TS827. From here the sawtooth voltage is fed to the X deflection selector and fed back to the input of the sweep-gating multivibrator, via the hold-off circuit. Moreover, there is a circuit which indicates whether the main time-base generator is triggered or not.

The sawtooth voltage is generated by charging one of the time-base capacitors with a constant current to a certain level. The capacitor is then short-circuited and, therefore, discharged very quickly. The voltage across the capacitor is then shaped as a sawtooth.

3.2.3.1. Sweep-gating multivibrator

Sweep-gating multivibrator TS801-TS802 is controlled by the following signals: the negative-going trigger pulses supplied by the main trigger-pulse shaper, the voltage supplied by the hold-off multivibrator and the input bias voltage supplied by the auto-circuit. The trigger stability is preset with potentiometer R806. Transistor TS805 is a current source to make the sweep-gating multivibrator insensitive for possible fluctuations in the supply voltage. The output square-wave of the sweep-gating multivibrator is applied to the switching transistors TS807 and TS808.

3.2.3.2. Switching transistors TS807 and TS808

Transistor TS808 is the switching transistor which is direct in parallel with the relevant time-base capacitor. As soon as this transistor receives a positive base voltage or current, it starts conducting and the time-base capacitor is discharged.
Transistor TS806 is the current source which provides a constant charging current for the time-base capacitors. Transistor TS807, the other switching transistor, short-circuits the charging current to earth when the time-base capacitors are being discharged. Both switching transistors are driven with the same control signal, supplied by the sweep-gating multivibrator.

3.2.3.3. Sweep speeds

The sweep speed or time coefficient is determined by the capacitance of the time-base capacitor concerned and by the magnitude of the charging current.

The time-base capacitors are C805, C806, C807 and C808.
Capacitor C806 is always in the circuit and the other capacitors are selected with the aid of transistors TS815, TS819 and TS821. These transistors are used as switches and work in two conditions only: hard on and hard off. A negative base voltage is used to turn the transistors off, to make sure that no collector current can flow. The transistors are turned on as soon as a positive voltage is applied to their base via the TIME/DIV switch SK14. The capacitor that is switched in by its appertaining transistor, is connected in parallel to capacitor C806.

The sweep speed is also selected by altering the magnitude of the constant charging current supplied by transistor TS806.
This current can be adjusted in steps by changing the emitter resistance of TS806 with the aid of TIME/DIV switch SK14. The charging current can be continuously controlled by changing the base drive of TS806 with the aid of TIME/DIV potentiometer R14. In the CAL position of the TIME/DIV potentiometer, switch SK15 is closed and the charging current is only determined by the calibrated emitter resistance.

To compensate for the temperature coefficient of the transistors (2 mV/^{o}C base-emitter junction), the base voltage of TS806 is supplied via transistor TS809. An extra advantage of this is a reduced load of the TIME/DIV potentiometer. Electrolytic capacitor C800 suppresses possible ripple and interference on the supply voltage.

Time-base capacitors C805, C806 and C808 are precision capacitors. Capacitor C807 (4,7 μF), however, has a ±10 % tolerance. This is compensated for by potentiometer R834 in the collector circuit of transistor TS811. With the aid of this potentiometer, the base voltage of TS809 is additionally controlled in those positions of the TIME/DIV switch where capacitor C807 is switched in. In positions where C807 is not switched in, diode GR802 is blocked and the additional control is inoperative.

3.2.3.4. Sawtooth take-off circuit

The sawtooth voltage that arises across the time-base capacitor is taken off via a Darlington circuit, comprising transistor TS826 and the left-hand transistor of TS827.
The emitter voltage of the left-hand TS827 transistor is applied to the X deflection selector, the comparator circuit and, via diode GR808, to the hold-off circuit of the main time-base generator.

3.2.3.5. Hold-off circuit

The purpose of the hold-off circuit is to prevent the sweep-gating multivibrator from responding to trigger pulses before the time-base capacitor has been completely discharged.

Via diode GR808, the sawtooth voltage is applied to the base of transistor TS824. The hold-off capacitors are part of the emitter circuit of this transistor. In every position of the TIME/DIV switch, a hold-off capacitor is switched in, in a similar way as the time-base capacitors.
Capacitor C812 is always in the circuit and the other capacitors, C809, C810 and C811, are switched in parallel to C812 by transistors TS820, TS821 and TS822, as dictated by the position of the TIME/DIV switch.

The selected hold-off capacitor is charged via transistor TS824 and discharged via TS825. Discharging in this case takes a considerably longer time than the discharging of the time-base capacitors. The bias of transistor TS825 can be varied by means of VAR. HOLD-OFF potentiometer R22 on the front panel, in order to manually vary the hold-off time.

The voltage across the selected hold-off capacitor drives Schmitt trigger TS816-TS817, the hold-off multivibrator. The output signal of the hold-off multivibrator is applied to the input of the sweep-gating multivibrator via emitter follower TS814. Emitter follower TS814 is there to isolate the trigger spikes supplied by the main trigger-pulse shaper from the hold-off multivibrator.

In the base circuit of transistor TS824 there is a switch SK9. This switch is closed when push-buttons AUTO and TRIG of the trigger-mode controls are depressed. If these buttons are released (push-button SINGLE depressed), switch SK9 is open. Then diode GR808 stops conducting and the hold-off multivibrator TS816-TS817 is no longer reset by the sweep voltage. The hold-off multivibrator is now reset via transistor TS818, by pressing SINGLE push-button SK9C.

The time-base generator must be switched off when it is not used to provide the X deflection voltage. This is obtained by depressing EXT X DEFL push-button SK2B of the horizontal-deflection controls, in the base circuit of transistor TS818. The hold-off multivibrator is then kept in such a state that its output voltage prevents the sweep-gating multivibrator from responding to trigger-pulses.

3.2.3.6. Indication lamp NOT TRIG'D

Indication lamp NOT TRIG'D is a light-emitting diode GR2 in the collector circuit of transistor TS812. This lamp serves two purposes.

In the first place it lights up when in the trigger modes AUTO and TRIG the time-base generator is not triggered. In that case, electrolytic capacitor C643 of the auto-circuit in the main trigger circuit is charged. As a result of this, the emitter voltage of transistor TS813 becomes less negative and the transistor turns off. Consequently, transistor TS812 starts conducting via resistor R838 and diode GR2 lights up. As soon as there are trigger pulses again, C643 is discharged, the emitter voltage of TS813 becomes more negative and the transistor starts conducting. Consequently, TS812 stops conducting and GR2 does not light up any longer.

In the second place the lamp is used as reset indicator in the SINGLE mode. If the SINGLE push-button has been pressed, the lamp lights up until the sweep is initiated by a trigger pulse. In this mode, transistor TS813 is driven on its base, the base drive depending on the state of hold-off multivibrator TS816-TS817.

3.2.3.7. Switching transistors TS803 and TS804

Transistors TS803 and 804 are part of the output circuit of the sweep-gating multivibrator. Transistor TS803 supplies pulses for the ALT supply of channels A and B to the channel selector logic, and reset pulses for the delayed time-base generator. Transistor TS804 provides blanking pulses that are applied to the Z amplifier, via the switching unit, in order to suppress the beam when the time-base generator is in the hold-off position.

3.2.3.8. D.C. Supply for the comparator circuit

The comparator, which will be discussed at a later stage, is used to start the delayed time-base generator at a certain time during the sweep of the main time-base generator. To this end, the sweep voltage of the main time-base generator is compared with an adjustable d.c. voltage. This d.c. voltage is controlled with DELAY TIME potentiometer R1 on the front panel. Potentiometer R1 receives its d.c. supply voltage via transistors TS829 and TS831. The set voltage is fed to the comparator via the right-hand transistor of TS827.
In the PM 3260 standard model, the beginning and the end of the multiplier scale can be calibrated with the aid of preset potentiometers R1513 and R1514.

3.2.4. Triggering of the delayed time-base generator

The delayed trigger circuit is a stripped version of the main trigger circuit. Therefore, please refer to section 3.2.2. **Triggering of the main time-base generator** for a description of the various circuits.

3.2.5. Delayed time-base generator

The delayed time-base generator is basically equal to the main time-base generator and, therefore, we shall only discuss the differences. For a description of the rest of the circuitry, please refer to section 3.2.3. **Main time-base generator.**

3.2.5.1. Sweep speeds

The circuitry is similar to that of the main time-base generator, but the constant current source for the time-base capacitors is provided with an extra preset potentiometer R1227. This potentiometer enables the sweep speeds of the delayed time-base generator to be equalized to those of the main time-base generator.

3.2.5.2. Hold-off circuit

Via diode GR1204 and emitter-follower TS1224, the sawtooth voltage is applied to hold-off multivibrator TS1218-TS1219.
The output voltage of the hold-off multivibrator brings the sweep-gating multivibrator in the hold-off position via emitter follower TS1217. The sweep-gating multivibrator is reset with the aid of reset multivibrator TS1222-TS1223.
The base of TS1223 is driven by the output signal of the sweep-gating multivibrator in the main time-base generator and by the output signal of the comparator. The reset multivibrator is switched over by the combination of these signals.

As a result of this, the hold-off multivibrator is reset via emitter follower TS1221 and, thus, the sweep-gating multivibrator TS1201-TS1202. If push-button STARTS SK8 has been depressed, the next sweep is then initiated.
If, however, TRIG push-button SK8 has been depressed, the sweep-gating multivibrator is switched over by a trigger pulse on the base of transistor TS1201. In position OFF of TIME/DIV switch SK12, the sweep-gating multivibrator is kept in such a state that it responds to neither trigger pulses nor reset pulses of the hold-off multivibrator.

3.2.5.3. Comparator

The comparator comprises the transistors TS1226 and TS1227. Transistor TS1226 is a double transistor in long-tailed pair circuit, TS1227 being a current source for this circuit. The d.c. voltage set by DELAY TIME potentiometer R1 is fed to the base of the right-hand transistor of TS1226, via R1282. The sawtooth voltage of the main time-base generator is fed to the left-hand transistor of TS1226, via R1281. As soon as the amplitude of the sawtooth exceeds the set d.c. voltage, the collector voltage of the left-hand transistor of TS1226 drops. This voltage drop is, together with the output signal of the sweep-gating multivibrator of the time-base generator, fed to the reset multivibrator TS1222-TS1223 as described in the previous section.

3.2.6. Switching unit or X deflection selector

The switching unit comprises the following circuits:
– A selector for the X deflection source.
– A switching circuit of the blanking pulses for the c.r.t.
– An X pre-amplifier for external X deflection signals.
– An X intermediate amplifier.

3.2.6.1. Selector for X deflection source

This circuit allows choice from X deflection by the main time-base signal, the delayed time-base signal or the signal from an external source. The deflection source is selected with the aid of X deflection controls SK2 MAIN TB, DEL'D TB, EXT X DEFL.

Push-button MAIN TB SK2 depressed: transistor TS1407 starts conducting. As a result of this, diodes GR1401 and GR1402 start conducting and the output signal of the main time-base generator is fed to the intermediate X amplifier. The conductance of transistor TS1407 also has as a consequence that transistors TS1408 and TS1409 are turned off. As a result of this, diodes GR1403-GR1404 and GR1406-GR1407 are blocked and signals from the delayed time-base or external X deflection signals are not transmitted.
Depressing MAIN TB push-button SK2 also results in conductance of transistor TS1404. Conductance of TS1404 causes transistor TS1406 to turn off and resistor R1422, the load of the main time-base generator, is out of the circuit, being replaced by R1423. The load of the main time-base generator remains, therefore, the same in all positions of the X deflection controls.

Depressing push-button EXT X DEFL SK2 and DEL'D TB SK2 has an analogous effect. The load of the delayed time-base generator also remains the same in all positions of the X deflection controls, as load resistor R1421 is replaced by R1424 when push-button DEL'D TB is depressed.

3.2.6.2. Switching circuit for blanking pulses

The switching circuit for blanking pulses comprises transistors TS1419 ... TS1426. The collectors of TS1422 and TS1424 have been connected to resistor R507, the input of the Z amplifier.
The current injected into the Z amplifier by these transistors is 0 mA for unblanking of the trace and 3 mA for the complete blanking of the trace.

The emitters of transistors TS1419 and TS1423 are, via load resistors R1474 and R1489, connected to respectively resistor R819 in the main time-base generator and resistor R1219 in the delayed time-base generator. During the sweep, 3 mA flows into the main time-base generator and during the hold-off period 0 mA. If the delayed time-base TIME/DIV switch occupies the OFF position, 3 mA flows into the delayed time-base generator.
These currents are supplied via resistors R1473 and R1491.
The collector currents of TS1419 and TS1423 are 5 mA during the hold-off period and 2 mA during the sweep. Of these collector currents, 2 mA flows to the −15 V supply via resistors R1479 and R1492. This results in a current for trace unblanking of 2−2 = 0 mA and a current for trace blanking of 5−2 = 3 mA.

Assume that the main time-base generator is switched in, i.e. MAIN TB switch SK2 closed. Then transistor TS1421 is blocked and the current step from 0 to 3 mA is applied to the Z amplifier, via transistor TS1422. If MAIN TB SK2 is open, i.e. the main time-base generator is not switched in, transistor TS1421 is conducting and the full current step from 0 to 3 mA is short-circuited via this transistor.
The input current of the Z amplifier is then 0 and the Z amplifier gives bright-up information.

Assume that only the delayed time-base generator is switched in, i.e. DEL'D TB SK2 closed. Then transistor TS1426 is blocked and the 0 to 3 mA bright-up information is fed to the Z amplifier, via transistor TS1424. If push-button EXT X DEFL SK2B is depressed, transistor TS1424 is blocked with as a result that the blanking information of the delayed time-base generator is not transmitted to the Z amplifier. The current step of the main time-base generator is short-circuited by the conducting transistor TS1421. The Z amplifier, therefore, receives no input current and the trace is unblanked.

The last possibility is mains time-base intensified by delayed time-base. During the part of the sweep where only the main time-base is running and not yet the delayed time-base, there flows no current to the Z amplifier via transistor TS1422, meaning unblanking of the trace.
However, the Z amplifier receives a 3 mA current from the delayed time-base via transistor TS1424. Thus, the trace is blanked as the nett input current of the Z amplifier is 3 mA. As soon as the delayed time-base starts and the intensified part begins, the current through transistor TS1424 is 0 and the Z amplifier brights up the trace. At the end of the delayed sweep, the current through TS1424 becomes 3 mA again and the trace is blanked. This would means that only the intensified portion of the trace is visible. However, it is possible to drain off part of the 3 mA through TS1424 via transistor TS1426 which is in parallel with the former. Depending on the position of INTENS potentiometer R20, a certain part of the current supplied by transistor TS1423 is drained off by TS1426.
This means that the dark level in the main time-base intensified by delayed time-base mode can be controlled via TS1426.
During the intensified portion, 0 mA flows to the Z amplifier which means complete unblanking of the trace. The intensity of the trace, however, can be controlled by INTENS potentiometer R20 which also acts upon the cathode current of the c.r.t. This control operates in such a way that the intensity relation between the normal and intensified part of the trace always remains the same. The ratio between both intensities can be set by means of potentiometer R1498.

3.2.6.3. X Pre-amplifier for external X deflection signals

The X pre-amplifier comprises transistors TS1400 ... TS1403.
The input signal of this circuit is applied to the emitter of transistor TS1400, via resistor R1404. The input signal may be one of the signals which can also be used for triggering, viz. the voltage on EXT input socket BU8, the channel A signal, the channel B signal or a mains-derived signal (also refer to section 3.2.2.1.).

If push-button EXT X DEFL of the horizontal deflection controls is depressed, the collector signal of transistor TS609 in the main trigger circuit is fed to R1404. The signal is amplified by transistors TS1400 and TS1402 and then applied to diode GR1406 in the X deflection selector. The base bias of transistor TS1400 is adjustable by means of pre-set potentiometer R1401. This potentiometer is used to balance the amplifier in such a way that rotating continuous X AMPL control R22 does not result in a trace shift on the screen. The amplifier gain can be controlled by X AMPL potentiometer R22 in the gate circuit of field-effect transistor TS1403, the latter being used as a variable resistor.
The gain is preset with potentiometer R1419.

Transistor TS1401 is a constant current source, being the collector load of transistor TS1402.

3.2.6.4. Intermediate X amplifier

The intermediate X amplifier comprises transistors TS1412 to TS1418. The asymmetrical output signal of the X deflection selector (anodes of GR1402, 1404 and 1407) is applied to the base of transistors TS1412 and TS1413. An anti-phase signal is generated by means of transistors TS1417 and TS1418, resulting in a symmetrical signal being fed to the X output amplifier. The base bias of transistors TS1417 and TS1418 can be varied with X POSITION potentiometer R2. Variation of the bias causes the balance of the push-pull amplifier to be disturbed, which results in a horizontal trace shift on the screen.

The amplifier offers the possibility of using either the nominal gain (x1 position of TB MAGN switch SK3), or the gain increased by a factor of 10 (x10 position of the TB MAGN switch).

In the x1 position of TB MAGN switch SK3, current source TS1416 in the emitter circuits of transistors TS1413 and TS1418 is switched in.

Then these transistors are operative, but not transistors TS1412 and TS1417 because their current source TS1414 is turned off. The gain of this stage can be set by means of potentiometer R1462.

In the x10 position of TB MAGN switch SK3, TS1414 starts conducting. Consequently, transistor TS1416 turns off.
Transistors TS1412 and TS1417 are switched in and the amplifier stage with TS1413 and TS1418 is inoperative. The gain of amplifier stage TS1412-TS1417 is ten times higher than that of the previously discussed stage, and can be set by means of potentiometer R1444. Light-emitting diode GR1 indicates the 10x TB MAGN condition. The x10 amplifier is also inoperative when the EXT X DEFL push-button is depressed (SK2B open).

The outputs of both amplifier stages are connected to the final X amplifier by means of coaxial cables.

3.2.7. Final X amplifier

The final X amplifier consists of two amplifier stages in parallel (one for each deflection plate). In the following we shall describe one half.

The actual amplifier is the cascode circuit with transistors TS1702 and TS1703. Resistors R1704 and R1707 are feedback resistors. The cascode amplifier is controlled via the transistor TS1704 in common-base configuration. Resistor R1712 is the termination for the coaxial cable between the intermediate X amplifier. Current source TS1701 supplies the bias current for the amplifier.
The average voltage on the deflection plate is kept at +26 V by means of Zener diode GR1702. Capacitor C1701 improves the h.f. response and trimmer C1703 allows phase compensation in the feedback path of the cascode circuit.

3.2.8. C.r.t. circuits

3.2.8.1. Z Amplifier

Input signals are fed to the Z amplifier via resistors R506 and R507. The blanking pulses of the time base are fed to R506 and those of the chopper to R507. Transistor TS504 in common base configuration feeds the current pulses (see also section 3.2.6.2.) to the actual amplifier TS508-TS509.
The brilliance of the trace is controlled by means of INTENS potentiometer R20. Depending on the position of this potentiometer a smaller or larger part of the input current is drained off via transistor TS503. The larger the current drain, the more brilliant the trace.

The blanking signal is amplified in the stage with transistors TS508 and TS509, and taken off via emitter follower TS507.
Diode GR506 in the collector circuit of transistor TS504 clamps the dark level of the blanking current to the amplifier to 3 mA. Trimmer C509 allows optimum adjustment of the frequency response.

From the output of emitter follower TS507, the a.c. and d.c. components of the blanking signal are guided along different paths. The a.c. path runs straight to the Wehnelt cylinder of the c.r.t. via capacitor C522.

A d.c. signal is fed to the emitter of transistor TS512, via low-pass filter R534/C511 and resistor R532. Transistor TS512 constitutes a multivibrator together with transistor TS511.
The a.c. voltage on the collector of TS512 has a peak-to-peak value which depends on the voltage fed to the emitter of TS511 by the Z amplifier. The frequency of the multivibrator signal is approximately 30 kHz.

The following part of the d.c. path is encapsulated in compound as a protection from humidity and to keep the physical dimensions of the circuit as small as possible. The encapsulation contains a peak detector to rectify the a.c. voltage supplied by multivibrator TS511-TS512. Furthermore, there is a circuit for the bias voltages of the cathode and the Wehnelt cylinder of the c.r.t., and a supply circuit for the voltage on focussing anode g3.

The reason for the a.c. and d.c. paths is isolation of the cathode and Wehnelt cylinder, which are on a −2 kV potential, from the other circuits. The a.c. component of the blanking signal is transmitted straight away to the high-voltage part, via blocking capacitor C522 which is a high-voltage capacitor. The d.c. signal, however, is converted into an a.c. voltage and then transmitted to the high-voltage part, via capacitor C521, after which it is rectified.
The dark level can be adjusted with the aid of potentiometer R547 in the emitter circuit of transistor TS512 in the d.c. amplifier.

3.2.8.2. Focusing circuit

The electron beam is focussed with the aid of FOCUS potentiometer R21 which controls the emitter voltage of transistor TS514.
This transistor constitutes, together with transistor TS513, a multivibrator identical to the one with transistors TS511 and TS512. Across the collector resistor of TS514, R555, a signal arises whose amplitude depends on the position of FOCUS potentiometer R21. This signal is rectified in the encapsulated circuit which comprises, to this end, a double peak detector. The rectified voltage, approx. 200 V, is applied to focusing anode g3 of the c.r.t.

The emitter voltage of transistor TS514 does not only depend on the position of the FOCUS potentiometer, but is also determined by the position of INTENSITY potentiometer R20.
The signal from this potentiometer is applied to the emitter of TS514, via transistor TS516. In this way a kind of compensation is obtained: the focus of the electron beam is automatically adapted when the brilliance of the trace is varied. The necessity of readjusting the FOCUS control after rotating the INTENS potentiometer is, thus, largely obviated.

3.2.8.3. E.H.T. Converter

The converter circuit supplies a voltage of −2 kV for the cathode and the Wehnelt cylinder of the c.r.t., and a voltage of +18 kV for post-acceleration anode g9. The main components of the converter are oscillator TS2004 and transformer T2001. Across the secondary winding of transformer T2001, an a.c. voltage of periodically + and −2 kV arises.
This voltage is rectified by diode GR2001 and fed to the previously mentioned encapsulated circuit. The voltage on the anode of diode GR2001 is −2170 V. The secondary voltage of transformer T2001 is also rectified and multiplied by a factor of 9 in an encapsulated multiplier circuit, in order to obtain the required +18 kV. The converter frequency is 25 to 30 kHz.

The output voltage of the converter is kept constant by means of a regulator circuit. This circuit comprises transistors TS2001 and TS2003. The 2 kV voltage on the cathode of the c.r.t. is fed back to the base of transistor TS2003, via resistor R573 in the encapsulated circuit. If this voltage drops, the base current of transistor TS2003 increases, as its base voltage is also connected to the +45 V voltage via resistors R2002 and R2003. An increasing base current of transistor TS2003 causes the current through transistor TS2001 to increase. As a result of this, the base current of transistor TS2004 grows and the generated voltage increases. The regulation operates in an analoguous way, but in reverse direction, when the 2 kV voltage rises.

The 2 kV voltage is also protected against short circuits (the 18 kV voltage is protected by its high internal resistance).
If the current drain from GR2001 becomes too high, diode GR2003 turns off. Under normal conditions, this diode is always conducting. This means that normally the cathode is approximately 0,7 V negative with respect to earth. In case of overload or short-circuit of the 2kV voltage, this 0,7 V is cancelled out or may even become positive, depending on the magnitude of the short-circuit current. This causes the base voltage of transistor TS2002 to go positive and this transistor starts conducting. As a result of this, the current through transistor TS2003 decreases, causing a reduction of the current through transistor TS2001. Consequently, the base current of transistor TS2004 decreases and the converter switches off.
To avoid too high a load of the lower supply (section 3.2.9.) during switching on, the 2 kV oscillator is switched on after a delay of 0,3 s caused by capacitor C2005.

3.2.9. Power supply

The circuitry of the power supply has been designed in such a way, that the instrument can be connected to any mains voltage between 90 V and 264 V, without the necessity of adaptation to the local mains voltage.
The various output voltages of the power supply unit are stabilized.
The circuit is provided with a current limitation for overload protection.

3.2.9.1. Mains unit

The mains voltage is applied to the mains filter, via POWER switch SK22 and fuse VL1. The mains filter consists of two double coils L1801 and L1802, and capacitors C1801, C1802 and C1803. Between this filter and the rectifier bridge, there is a second filter consisting of resistor R1801 and capacitor C1804. Both filters are used to suppress interference from the mains to the instrument and from the instrument to the mains.

The rectifier bridge comprises two series diodes in each branche. The ripple which results after rectifying the a.c. voltage is smoothed in the circuit with transistors TS1800 and TS1805. This circuit works as follows. Assume that the output voltage on the right-hand side of electrolytic capacitor C1807 rises. Then transistor TS1805 draws less current. This means that the base current of TS1800 decreases. Consequently, the collector voltage of transistor TS1800, which is also the output voltage, drops. In other words, the d.c. output level coincides with the lower level of the ripple voltage superimposed on the unsmoothed, rectified voltage.

3.2.9.2. Switching series regulator

In principle, the switching series regulator consists of switching transistor TS18001 with choke L1804, smoothing capacitors C1808 and C1809, and diode GR1811. The base of transistor TS1801 is driven by a square-wave signal which periodically turns this transistor on and off. The on-off ratio can be varied and is determined by the regulator circuit.
The circuit operates as follows. When transistor TS1801 is conducting, capacitors C1808 and C1809 are charged and the magnetic field in L1804 is built up. When TS1801 is cut off, L1804 is "discharged" via GR1811.

This is repeated with a frequency equal to the chopper frequency (refer to section 3.2.9.3.). Capacitors C1808 and C1809 are shunted by the series circuit of resistors R1807 and R1808. These resistors divide the voltage equally over capacitors C1808 and C1809. To facilitate the starting of the circuit, a minute base current is fed to transistor TS1801, via resistors R1817, R1804 and R1803.
When transistor TS1801 is cut off, its base is slightly negative due to the diode and parallel capacitor in the base circuit.

3.2.9.3. Chopper

The chopper is a push-pull oscillator with transistors TS1803 and TS1804. These transistors are driven on the base by transformer T1801. The primary winding of converter transformer TS1802 has been connected to the collectors of TS1803 and TS1804. The chopper circuit generates a square-wave signal, as driver transformer TS1801 comes very easily into saturation. The primary winding of T1801 is connected to winding 7-8 of transformer T1802, via resistor R1833. The chopper circuit is started with the aid of pnpn transistor TS1802. As soon as the instrument is switched in, transistor TS1801 is driven by a minute base current, supplied via resistors R1803, R1804 and R1817. Capacitors C1807 and C1808 are then charged by the collector current of TS1801.
When the voltage across these capacitors attains a certain value, diode GR1814 starts conducting via resistor R1811.
As a result of this, transistor TS1802 ignites and supplies via resistor R1813 a base current to transistor TS1803 which starts conducting. As soon as transistor TS1802 conducts, the voltage across resistor R1811 increases and the current through diode GR1814 stops. Diode GR1813, however, starts conducting and a stable state is obtained.

Between point 6 of driver transformer TS1801 and the emitters of the chopper transistors, there is a circuit with diode GR1816 and electrolytic capacitor C1812. This circuit compensates for the hole-storage capacitance of transistors TS1803 and TS1804. During the oscillating, a voltage arises across capacitor C1812 and diode GR1816, which makes the cathode of GR1816 approximately 0,8 V negative with respect to its anode.
As a result of this, the base voltage of the blocked chopper transistor will be markedly negative. In this way, a faster switching of the chopper transistors is obtained.
The frequency of the chopper is approximately 17 kHz.

3.2.9.4. Regulator circuit

The output voltage of the chopper is regulated, after comparing the voltage across winding 7-8 of transformer T1802 with a reference voltage. The main component parts of the regulator circuit are transistor TS1806, potentiometer R1828 and integrated circuit IC1801. IC1801 comprises a reference voltage source and an operational amplifier.

The regulator circuit operates as follows. Across winding 7-8 of transformer TS1802 there is a square-wave voltage of 20 $V_{p\text{-}p}$. This voltage is rectified and results in a voltage of approximately −9 V plus a ripple voltage of approximately 0,2 $V_{p\text{-}p}$ across capacitor C1817. This ripple voltage is essential for the working of the regulator circuit.
Non-inverting input 3 of IC1801 has been connected to the wiper of potentiometer R1828. This potentiometer has been connected in parallel to capacitor C1817, via resistors R1827 and R1829 and diode GR1823. Diode GR1823 conducts via resistor R1831. Capacitor C1816 is fitted between the positive electrode of capacitor C1817 and the wiper of potentiometer R1828, in order to smooth the ripple voltage across C1817.

Consequently, the voltage on input 3 of IC1801 is a d.c. voltage. Inverting input 2 of IC1801 has been connected to point 4 of the integrated circuit, by means of resistor R1826. Within IC1801, there is a reference-voltage source between points 4 and 5. This circuit receives its supply voltage via point 8 of the integrated circuit.
The reference voltage between points 4 and 5 is approximately −7 V. The voltage on input 2 of the IC is approximately −2 V plus the 0,2 $V_{p\text{-}p}$ ripple voltage which is taken off from the negative side of capacitor C1817, via capacitor C1814. On output 6 of the IC there is a square-wave voltage, due to the large gain of IC1801. The on/off ratio of this voltage depends on the voltage between inputs 2 and 3 of the IC. The square-wave voltage on output 6 is applied to the base of transistor TS1806. The collector signal of TS1806 is used to drive transistor TS1801 of the switching series regulator.

Assume that for some reason the voltage across capacitor C1817 increases. The voltage on input 2 of IC1801 then goes more negative. The voltage on input 3 goes more negative too, but not as much as the voltage on input 2, because of the action of potentiometer R1828. In other words: the voltage on input 3 will be positive with respect to the voltage on input 2 of the IC. As a result of this, the output voltage on point 6 of the IC goes more positive; in terms of on/off ratio: the square-wave voltage will be 'on' during a longer time. This signal is inverted by transistor TS1806, with as a result that transistor TS1801 is blocked during a longer time. Consequently, the output voltage of the switching series regulator decreases.

There is also a foreward control, which means that IC1801 is also controlled by the mains voltage. To this end, input 3 of the IC has been connected to the rectified mains voltage, via resistor R1806. If the mains voltage increases, input 3 of IC1801 goes more positive with respect to input 2, with the same result as described in the previous section.

3.2.9.5. Current limiter

The current supplied by the power unit, also flows through resistor R1802 and the voltage drop across this resistor controls transistor TS1811. If the supply current becomes too high, transistor TS1811 starts conducting. As a result of this, pnpn transistor TS1808 ignites and causes a positive voltage on the base of transistor TS1806. This transistor becomes conductive and switching series-regulator transistor TS1801 is cut off. Because transistor TS1801 is blocked, the chopper stops operating. However, a minute base current is fed to transistor TS1801, via resistors R1803, R1804 and R1817. As a result of this, electrolytic capacitors C1808 and C1809 are slowly charged. At a certain moment the chopper starts again and is immediately switched off again if the short-circuit or overload still exists. This oscillation is repeated approximately once every three seconds (depending on the mains voltage) and the supply is switched off again as long as the short-circuit persists.
The current limitation is made independent of the temperature by means of n.t.c. resistor R1815.

3.2.9.6. Secondary supply voltages

The supply voltages for the various circuits in the instrument are obtained by rectifying and smoothing the secondary voltages of transformer TS1802.

The filament of the c.r.t. is supplied with the rectified voltage of winding 17-18. In this circuit, an n.t.c. resistor R1843 has been used, to compensate for the low filament resistance of the c.r.t. right after switching in. When the instrument is switched in, the filament has a low temperature and, therefore, a low resistance. This might cause starting problems for the oscillator. Because of the n.t.c. resistor, however, there is immediately a resistance in the filament circuit. After warming up of the n.t.c. resistor, the filament of the c.r.t. will receive its nominal voltage.

3.2.9.7. Mains coupler for triggering

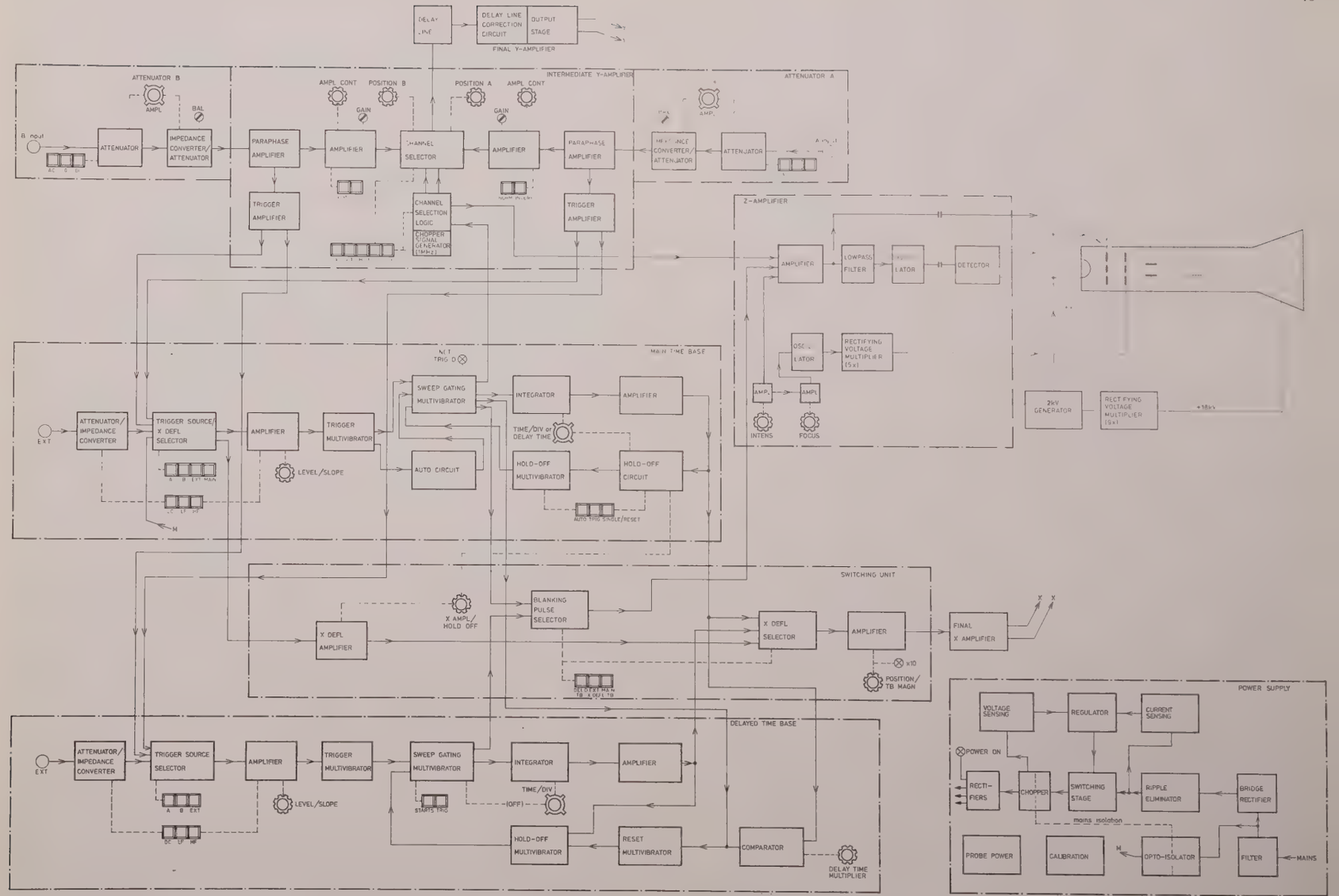
The trigger source for mains triggering is isolated from the mains by means of opto-isolator. This is in fact a Light Emitting Diode and a Photo Transistor in one encapsulation: TS1809. Through the LED of TS1809 there flows a d.c. current obtained by rectifying and smoothing the mains voltage with diode GR1828 and capacitor C1821.
The a.c. mains current is superimposed onto this d.c. current with the aid of R1836. The output voltage is taken off across resistor R1839. The amplitude of the output voltage can be adjusted by means of potentiometer R1818.

3.2.9.8. *Probe-power supply (not in PM 3260E)*

The instrument supplies a + and a −24 V d.c. voltage for active probes. The +24 V is obtained in an integrated circuit IC1614 of the same type as the one discussed in section 3.2.9.4. The stabilized output voltage is available on the PROBE POWER sockets of the instrument. It is also used to obtain the −24 V. The latter is derived from the former and stabilized in the circuit with transistors TS1611, TS1612 and TS1613.

3.2.10. Calibration unit

The calibration unit is a square-wave generator consisting of an operational amplifier IC1901 with feedback. The oscillator frequency is determined by resistor R1909 and capacitor C1903. Capacitor C1902 keeps point 3 of the IC constantly equal to the average output voltage. Consequently, the generator is independent of fluctuations in the supply voltage. The square-wave amplitude is determined by zener diode GR1901. Potentiometer R1906 allows accurate adjustment of the output voltage and output current.



MA8326A

Fig. 3.1. Block diagram

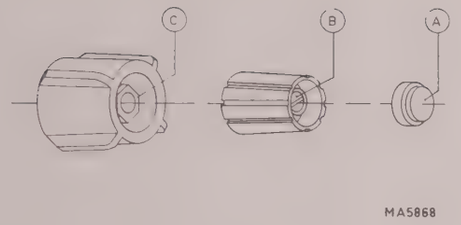


Fig. 3.2. Removing the knobs

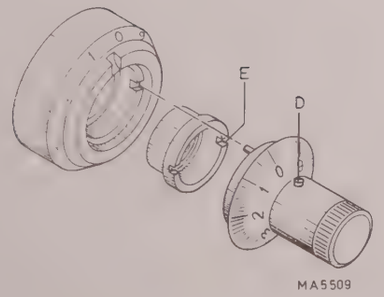


Fig. 3.3. Removing the delay-time multiplier knob

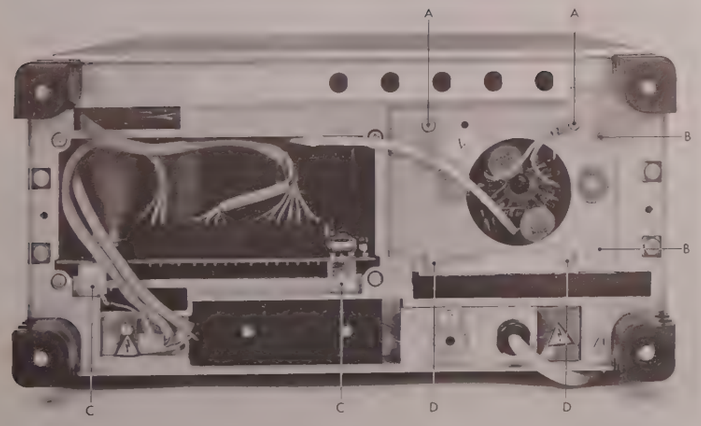


Fig. 3.4. Rear view with dismantling references

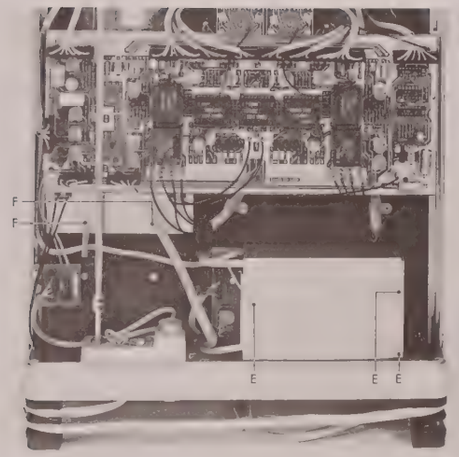


Fig. 3.5. Bottom view with dismantling references

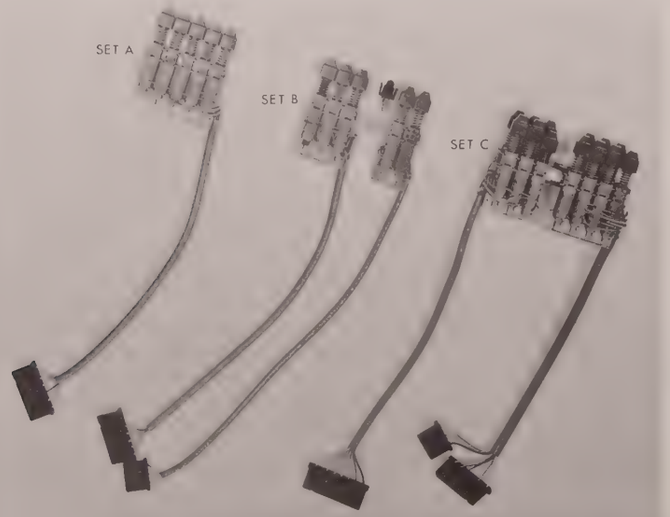


Fig. 3.6. Push-button sets

3.3. DISMANTLING THE INSTRUMENT

3.3.1. General information

This section provides the dismantling procedures required for the removal of components during repair operations. All circuit boards removed from the oscilloscope should be adequately protected against damage, and all normal precautions regarding the use of tools must be observed. During dismantling procedures, a careful note must be made of all disconnected leads so that they may be reconnected to their correct terminals during assembly.

When the E.H.T. cable to the post-acceleration anode of the c.r.t. is disconnected at the E.H.T. unit end, both E.H.T. cable and connector must be discharged immediately by shortening them to earth. The other end of the E.H.T. cable is unbreakably connected to the c.r.t.

Damage may result if the instrument is switched on when a circuit board has been removed, or if a circuit board is removed within one minute after switching off the instrument.

Make sure that the mains supply has been disconnected before removing the cabinet plates.

3.3.2. Removing the cabinet plates and the screen bezel

Both upper and lower cabinet plate can be removed after slackening one or two turns the four quick-release fasteners at the corners of each plate. Do not slacken the fasteners more than two turns, otherwise they may come apart.

The screen bezel can be detached by pulling its upper or lower edge.

3.3.3. Removing the knobs

3.3.3.1. Single knobs (Fig. 3.2)

– Prise off cap A
– Slacken screw (or nut) B
– Pull the knob from the spindle

3.3.3.2. Double knobs (Fig. 3.2)

– Prise off cap A and slacken screw B
– Pull the inner knob from the spindle
– Slacken nut C and pull the outer knob from the spindle

When fitting a knob or cap, ensure that the spindle is in a position which allows reference lines to be coincident with the markings on the text plate of the oscilloscope.

3.3.3.3. Delay-time multiplier knob (Fig. 3.3)
(not for PM 3260E)

– Slacken screw D using a hexagonal key and pull the knob from the spindle
– Remove the nut E and withdraw the ring from the spindle

When fitting the vernier control, turn the spindle of the potentiometer fully anticlockwise. Place the ring on the spindle so that the reference line corresponds to the zero mark on the calibrated scale. Then lock it with nut E. Fit the inner knob so that its cam is engaged with the slot in the ring. Rotate the inner knob until its zero mark coincides with the reference line on the ring. Secure the assembly by tightening screw D.

3.3.4. Removing the circuit boards of: **Main time-base**, **Delayed time-base**, **Switching unit**, **Intermediate amplifier**

These circuit boards can be easily removed after disconnecting the various plugs and unscrewing the screws that secure the boards to the chassis.

3.3.5. Removing the circuit board of the final X amplifier

- Remove the rear plate of the instrument (two screws)
- Remove the two screws A that secure the supports to the rear panel (Fig. 3.4.)
- Disconnect the miniature coaxial plugs and the single-wire connectors
- Unplug the four multipole connectors and disconnect the two wires from the c.r.t. pins
- Remove the circuit board from the oscilloscope

3.3.6. Removing the circuit board of the final Y amplifier

- Remove the rear plate of the instrument (2 screws)
- Slacken both screws of the final X amplifier
- Remove the two screws B which secure the supports to the rear panel (Fig. 3.4.).
- Disconnect the miniature coaxial plugs
- Unplug the multipole connectors and disconnect the two wires from the c.r.t. pins
- Remove the c.r.t. filter connections (2 soldering connections and 2 single-wire connectors on the soldering side of the board) and carefully lift out the circuit board

3.3.7. Removing the circuit board of the power supply (Fig. 3.4.)

- Remove the rear plate of the instrument (2 screws)
- Remove the screws C which secure the circuit board to the rear panel
- Unplug the three multipole connectors and disconnect the two single-wire connectors
- Disconnect the three wires of the mains filter
- Carefully withdraw the circuit board from its compartment

3.3.8. Removing the E.H.T. circuit board

- Remove the metal housing (three screws E in Fig. 3.5.)
- Unplug the multipole connectors
- Disconnect the E.H.T. connector after unscrewing the swivel nut and discharge the cable
- Unscrew the three hexagonal spacers and remove the circuit board
- Before screwing the E.H.T. cable on to a replacement board, the E.H.T. connector should be greased with Silicon Dielectric Compound. Order no. 4822 390 20023).

3.3.9. Removing the attenuator unit

- Remove the appropriate V/cm knobs and the nut under these knobs
- Unplug the multipole connector and the miniature coaxial plug on the circuit board of the intermediate amplifier
- Disconnect the earthing wire
- Remove the two screws that secure the lower part of the attenuator unit to the front panel
- Carefully lift the attenuator unit out of the oscilloscope

3.3.10. Removing the delay line

- Remove the rear plate of the instrument (2 screws)
- Remove the screws D (Fig. 3.4.) that secure the delay line to the rear panel
- Remove the two screws F (Fig. 3.5.) and the four miniature coaxial connectors
- Withdraw the delay line from the rear of the oscilloscope

3.3.11. Removing the focus unit

- Remove the circuit board of the X output amplifier in accordance with section 3.3.5.
- Remove the metal housing of the E.H.T. unit (3 screws E in Fig. 3.5.) and unplug the multipole connector of the focus unit
- Unsolder the three wires on the c.r.t. base (white, blue and yellow)
- Remove the focus unit by pressing the longer edges together

3.3.12. Removing the cathode-ray tube

ATTENTION: Be very careful with the side connections of the c.r.t. If these pins are bent, the c.r.t. is likely to develop a gas leak.

- Remove the delay line in accordance with section 3.3.10.
- Slacken the brace round the c.r.t. neck and remove the connections between c.r.t. and Y output amplifier.
- Remove the tube base
- Unplug the multipole connector of the orthogonality and trace-rotation coils on the intermediate amplifier
- Remove the metal housing of the E.H.T. unit and disconnect the E.H.T. cable (discharge the cable)
- Slacken the upper plastic centring bracket at the c.r.t. front
- Slacken the two screws that secure the mu-metal screening pipe to the rear chassis.
- Remove the bezel by pulling its lower edge
- Carefully withdraw the c.r.t. through the front panel of the instrument
- If the rubber sleeve around the neck of the c.r.t. must be slid over the neck of a replacement tube, the use of industrial talcum powder is strongly recommended.

3.3.13. Removing the push-button sets

Each of the push-button sets mentioned below is fitted to the front panel by means of two clamping devices:

The A/ALT/CHOP/ADD/B set (A in Fig. 3.6.)
The DEL'D TB/EXT X DEFL/MAIN TB set
The NORM/INVERT & NORM/INVERT set
The STARTS/TRIG & AUTO/TRIG/SINGLE set (B in Fig. 3.6.)
The DC/LF/HF & DC/LF/HF & A/B/EXT & A/B/EXT/MAINS set (C in Fig. 3.6.)

To remove a push-button set, the two recessed-head screws that secure the set to the front panel must be removed.
To replace one switch of a push-button set, refer to Fig. 3.7.

Before a push-button set is refitted, it is advisable to stick the two parts of the clamping device together by means of adhesive tape or non-hardening glue, in order to facilitate the replacement.

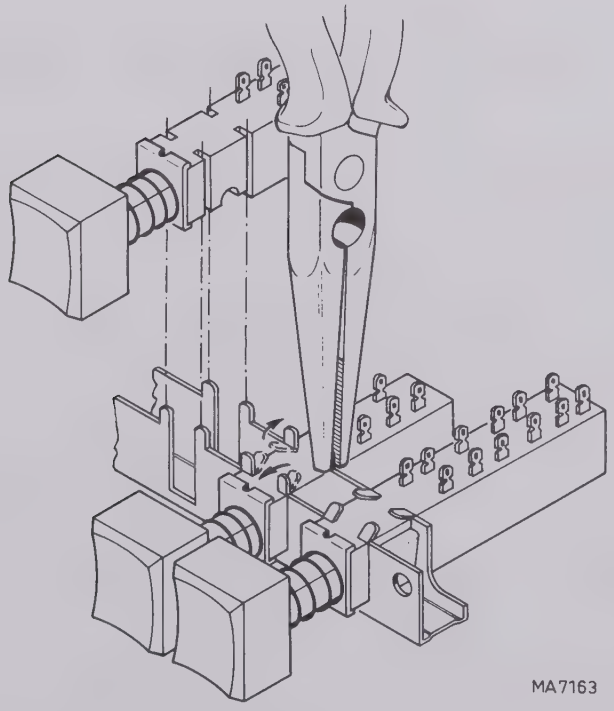


Fig. 3.7. Replacing a switch of a push-button set

3.3.14. Removing the carrying handle

1. Remove the upper and lower cabinet plates
2. Remove the plastic strip which is snapped on to the grip
3. Remove the four screws which secure the grip to the brackets
4. Depress the push-buttons in the brackets and turn the carrying handle as far as possible to the upper side of the oscilloscope
5. Keep the push-button of the right-hand bracket depressed and pull the bracket from its bearing[1)]
6. Remove the grip from the remaining bracket
7. Depress the push-button of the left-hand bracket and turn the latter as far as possible to the lower side of the instrument
8. Keep the push-button depressed and pull the bracket from its bearing

If it is impossible to remove the left-hand bracket in this way, remove also its bearing in a similar way as described in footnote 1).

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1) With some instruments it may be impossible to remove the handle in the described way. This is due to an extra securing plate in the right-hand bearing. In that case, DO NOT USE FORCE, but work in accordance with the following procedure which replaces points 3, 4 and 5.

3. Remove the two screws which secure the grip to the right-hand bracket
4. Remove the two hexagonal bolts which secure the right-hand bearing to the side strip
5. Depress the push-button of the right-hand bracket and take the bearing from the bracket.

3.3.15. Special tools

ATTENTION: When you are soldering inside the instrument it is essential to use a low-voltage soldering iron, the tip of which must be earthed to the mass of the oscilloscope.

3.3.15.1. Soldering iron for semi-conductors in micro-miniature plastic encapsulations (SOT23)

Because of the small dimensions of these SOT23 semi-conductors and the lack of space between the components on the printed-wiring board, it is necessary to use a miniature soldering iron with a pin-point tip (max. dia 1 mm) to solder a SOT23 on to a printed-wiring board.

Work method:
– Unsolder pin A (Fig. 3.8.)

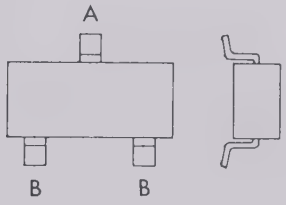


Fig. 3.8. SOT23 transistor

– Unsolder pins B and remove the SOT from the printed-wiring board
– Remove the superfluous solder and smooth down the soldering spots on the printed-wiring board. In this way, all three connection pins of the SOT are in contact with the printed conductors at the same time and damage to the SOT as a result of bending the pins, is prevented.
– Place the new SOT onto its soldering spot and keep it in place
– Solder the pins A and B to the printed-wiring board

NOTE: Bear in mind that the maximum permissible soldering time is 10 seconds during which the temperature of the pins must not exceed 250 °C. We, therefore, recommend the use of a solder with a low melting point, e.g. silver-containing solder (59 % tin, 34 % lead, 6 % silver, melting point 180 °C, order number 5322 390 84001).

Take care not damage the plastic encapsulation of the SOT during the soldering procedure (softening point of the plastic is 150 °C).

A suitable soldering-iron is e.g.
Low Voltage Mini Soldering Iron, Type 800/12 W - 6 V, power 12 W, voltage 6 V, order no. 4822 395 10004, in combination with 1-mm-pin-point tip, order no. 4822 395 10012.

3.3.15.2. Special tool for the slotted nut of attenuator switches A and B, order no. 5322 395 54023

For those who want to make such a tool, we give a sketch with the dimensions in mm in Fig. 3.9. The material is silversteel N094, tempered 40-45 Rc.

3.3.15.3. Special tool for the slotted nut of the POSITION and LEVEL/SLOPE potentiometers, order no. 5322 395 54024

For those who want to make such a tool, we give a sketch with the dimensions in mm in Fig. 3.10. The material is silversteel N094, tempered 40-45 Rc.

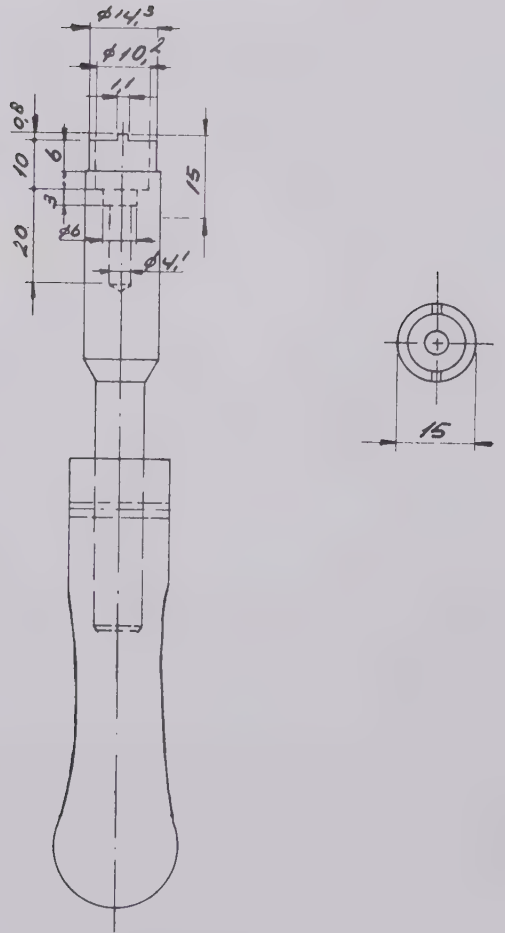


Fig. 3.9. Tool for attenuator unit

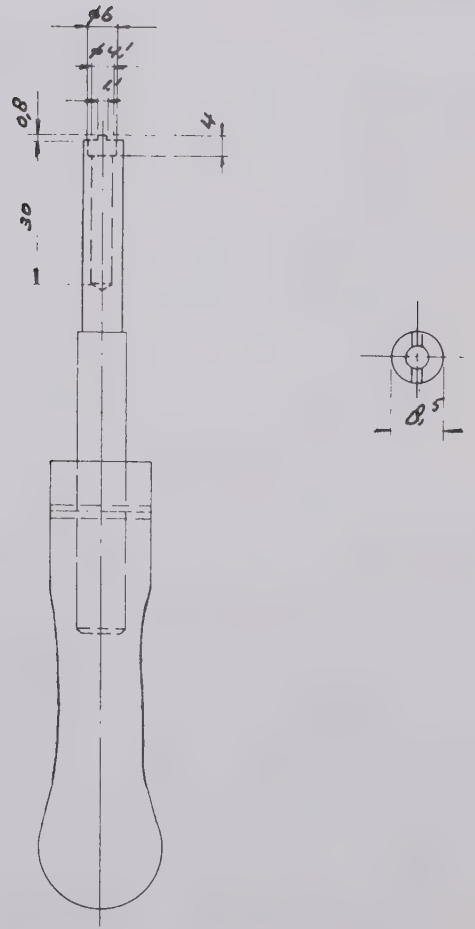


Fig. 3.10. Tool for positioning potentiometer

3.4. CHECKING AND ADJUSTING

The figures appertaining to the checking and adjusting procedure can be found at the end of section 3.4., pp. 104...108.

3.4.1. Performance check

3.4.1.1. Starting positions of the controls

- Connect the instrument to the mains
- Depress the ALT, MAIN TB and AUTO push-buttons
- Set the MAIN TIME/DIV switch to .1 ms
- Set the DEL'D TIME/DIV switch to OFF
- Set the AMPL switches to .1 V/DIV
- Set the TIME/DIV and AMPL potentiometers to CAL
- Set the TB MAGN switch to x1
- Set the POSITION potentiometers to their mid-positions
- Turn the INTENS and ILLUM potentiometers fully clockwise
- The controls not mentioned may occypy any position.
  Unless otherwise stated, the controls always occupy the same position as in the previous check.
- Set the POWER switch to ON
- Check that the POWER ON lamp lights up and that two time-base lines are displayed

3.4.1.2. C.r.t.

- Set the INTENS and FOCUS controls for a sharp, well-defined trace
- Centre both time-base lines, using the POSITION potentiometers
- Check that the traces run in parallel with the central horizontal graticule line; if necessary, readjust in accordance with section 3.4.2.4.4.

3.4.1.3. Vertical axes

D.C. Balance

- Depress the 0 button of the AC-0-DC switch
- Switch the AMPL step-attenuator between positions 5 mV/DIV and 10 mV/DIV
- Check that the trace does not jump more than 0,3 DIV. If necessary, readjust the BAL potentiometer on the front panel
- Repeat for the other channel

Trace height and pulse response

- Depress push-buttons A(B) of the display-mode controls, NORM of the signal-polarity controls and DC of the input-coupling switch
- Set the AMPL step attenuator to 10 mV/DIV
- Apply a square-wave signal with a rise time $\leqslant$ 1 ns, a peak-to-peak value of exactly 60 mV and a frequency of approx. 1 kHz to input socket A(B)
- Set the MAIN TB switch to a suitable position
- Obtain a stationary trace with the aid of the LEVEL potentiometer
- Check that the trace height is 6 DIV. If necessary, adjust the GAIN potentiometer on the front panel
- Check that the pulse top is straight within 3 % of the peak-to-peak value
- Increase the frequency of the input signal successively to 10 kHz, 100 kHz and 1 MHz
- Check that the pulse top remains straight within 3 % at these frequencies
- Set the MAIN TIME/DIV switch to 0.05 μs
- Pull the TB MAGN control to its x10 position
- Adjust the LEVEL control for a stable display
- Check that the rise time between 10 % and 90 % of the pulse height is $\leqslant$ 3 ns
- Push the TB MAGN control to its x1 position.
  If the pulse response of both channels does not meet the requirements stated above, readjust the vertical amplifiers in accordance with sections 3.4.2.5.3.

Bandwidth

- Connect a constant-amplitude sine-wave generator to input socket A(B)
- Set the generator to the reference frequency
- Adjust the output voltage of the generator to obtain a trace height of 8 DIV

– Increase the generator frequency until the trace height is 5,6 DIV
– Check that at this trace height the frequency exceeds 120 MHz

Common mode rejection

– Depress push-button ADD of the display-mode controls
– Depress the INVERT push-button of the channel B signal-polarity controls
– Set the AMPL switches to 5 mV/DIV
– Apply a sine-wave voltage simultaneously to sockets A and B
– Check the rejection in accordance with the following table

Note: Adjust the continuous AMPL control of channel A or channel B for minimum trace height

Input voltage	Generator frequency	Max. trace height	Rejection factor
120 mV	100 kHz	0,24 DIV	> 100
120 mV	2 MHz	0,24 DIV	> 100
120 mV	50 MHz	1,20 DIV	> 20

– Disconnect the input voltage

Chopped mode

– Depress push-button CHOP of the display-mode controls
– Set the MAIN TIME/DIV switch to 0,2 μs
– Check that there are two time base lines displayed which can be shifted with respect to one another, using the POSITION controls

Alternate mode

– Depress the ALT push-button of the display-mode controls
– Set the MAIN TIME/DIV switch to 10 μs
– Check that there are two time-base lines displayed which can be shifted with respect to one another, using the POSITION controls
– Set the MAIN TIME/DIV switch to 0,1 s
– Check that the channels are switched over after every sweep of the sawtooth voltage

3.4.1.4. Main time-base generator

Trigger slope, level and sensitivity

– Depress push-button A of the display-mode controls
– Set the channel A AMPL switch to .2 V/DIV
– Depress the AC push-button of the channel A signal-coupling controls
– Depress the DC push-button of the main time-base trigger coupling controls
– Apply a sine-wave signal with an amplitude of 1,6 V to input socket A, frequency approximately 30 kHz
– Set the MAIN TIME/DIV switch to such a position that a few cycles of the input sine wave are displayed.
– Push the SLOPE switch to its + position
– Check that the time-base generator starts on the positive-going part of the sine wave
– Pull the SLOPE switch to its – position
– Check that the time-base generator starts on the negative-going part of the sine wave
– Set the AMPL switch to position .1 V/DIV
– Position the trace in such a way that the bottom half of the signal is displayed
– Check that it is possible to shift the starting point of the sine wave over 8 DIV, by means of the LEVEL control
– Push the SLOPE switch to its + position
– Position the trace in such a way that the top half of the signal is displayed
– Check that it is possible to shift the starting point of the sine wave over 8 DIV, by means of the LEVEL control
– Reduce the input signal until the trace height is 0,5 DIV
– Check that the display remains triggered; if necessary readjust the setting of the LEVEL control.

Single-sweep operation

- Set the AMPL switch to .2 V/DIV
- Set the LEVEL control to mid-range
- Set the MAIN TIME/DIV switch to 0,1 s
- Depress push-button 0 of the channel A signal-coupling controls
- Push the SINGLE button of the trigger-mode controls
- Check that the NOT TRIG'D lamp lights up
- Depress push-button AC of the channel A signal-coupling controls
- Check that the trace is written once and that the NOT TRIG'D lamp is extinguished at the start of the sweep

Triggering on the mains frequency

- Depress the AUT button of the trigger-mode controls
- Depress the HF push-button of the trigger-coupling controls
- Set the MAIN TIME/DIV switch to 5 ms
- Apply a sine-wave signal at the mains frequency to input socket A
- Adjust the AMPL controls to obtain a trace height of 3 DIV
- There is no stable triggered display
- Depress push-button MAINS of the trigger-source controls
- Check that a stable display can be obtained by means of the LEVEL potentiometer

Time coefficients

- Set the AMPL switch to 0.1 V and the AMPL potentiometer to CAL
- Depress push-button DC of the trigger-coupling controls
- Set the MAIN TIME/DIV switch to 0.1 ms
- Depress push-button A of the trigger-source controls
- Apply a time-marker signal with a repetition time of 0,1 ms and an amplitude of approximately 600 mV to input socket A
- Check that the 8 centre periods have a total width of 8 DIV ± 2 % (in temperature range +20 °C ... +30 °C)
- Pull the TB MAGN switch to its x10 position
- Change the repetition time of the input signal to 10 μs
- Check that the 8 centre periods have a total width of 8 DIV ± 2 % (in temperature range +20 °C ... +30 °C)
- Push the TB MAGN switch to its x1 position
- Set the MAIN TIME/DIV switch to 10 ms
- Change the repetition time of the input signal to 10 ms
- Check that for the 8 centre pulses a display of one pulse per division is obtained
- Check all the other time-base positions in the same way

If the requirements stated above are not met, readjust the main time-base generator in accordance with section 3.4.2.7.1.

- Check that the control range of the MAIN TIME/DIV vernier control is 1 : 2,6 to 1 : 3,5

3.4.1.5. Delayed time-base generator

Trigger slope and level

- Depress push-button DEL'D TB of the horizontal-deflection controls
- Depress push-button A of the del'd tb trigger source controls
- Set the channel A AMPL switch to .2 V/DIV
- Depress the AC push-button of the channel A signal-coupling controls
- Depress the DC push-button of the delayed time-base trigger-coupling controls
- Depress push-button TRIG of the delayed time-base trigger-mode controls
- Set the MAIN TIME/DIV switch to 20 ms and the DEL'D TIME/DIV switch to 10 μs
- Apply a sine-wave signal with an amplitude of 1,6 V to input socket A, frequency approximately 30 kHz
- Push the SLOPE switch of the delayed time-base generator to its + position
- Check that the time-base generator starts on the positive-going part of the sine wave
- Pull the SLOPE switch of the delayed time-base generator to its – position
- Check that the time-base generator starts on the negative-going part of the sine-wave
- Set the AMPL switch to position .1 V/DIV

– Position the trace in such a way that the bottom half of the signal is displayed
– Check that it is possible to shift the starting point of the sine wave over 8 DIV, by means of the delayed time-base LEVEL control
– Position the trace in such a way that the top half of the signal is displayed
– Check that it is possible to shift the starting point of the sine wave over 8 DIV, by means of the delayed time-base LEVEL control

Time coefficients

– Turn the DELAY TIME control fully anti-clockwise
– Set the MAIN TIME/DIV switch to 0.2 ms and the DEL'D TIME/DIV switch to 0.1 ms
– Apply a time-marker signal with a repetition time of 0,1 ms and with an amplitude of approximately 600 mV to input socket A
– Check that the centre 8 periods have a total width of 8 DIV ± 2 % (in temperature range +20 °C ... +30 °C)
– Set the MAIN TIME/DIV switch to 20 ms and the DEL'D TIME/DIV switch to 10 ms
– Change the repetition time of the input signal to 10 ms
– Check that the centre 8 periods have a total width of 8 DIV ± 2 % (in temperature range +20 °C ... +30 °C)
– Check all the other time-base positions in the same way

If the requirements stated above are not met, readjust the del'd time-base generator in accordance with section 3.4.2.7.2.

– Check that the control range of the DEL'D TIME/DIV vernier control is 1 : 2,6 to 1 : 3,5

Delay time

– Depress push-button MAIN TB of the horizontal deflection controls
– Depress push-button STARTS of the trigger-mode controls
– Set the MAIN TIME/DIV switch to 0.1 ms and the DEL'D TIME/DIV switch to 0.05 μs
– Apply a time-marker signal with a repetition time of 0,1 ms to input socket A
– Adjust the LEVEL potentiometer of the main time-base generator for a stable, triggered display
– Check that the intensity modulation of the delayed time-base is visible over the entire control range of the INTENS potentiometer
– Check that the starting point of the delayed time-base (beginning of the intensified portion) can be continuously shifted in relation to the main time-base, by rotating the DELAY TIME control

The previous part of this section holds good for both PM 3260 and PM 3260E models. The following part, however, applies to the PM 3260 model only.

– Set the DELAY TIME control to 1.00
– Check that the start of the delayed time-base coincides with the start of the second time-marker pulse
– Set the DELAY TIME control to 9.00
– Check that the start of the delayed time-base coincides with the start of the tenth time-marker pulse.

If these requirements are not met, readjust the delay time in accordance with section 3.4.2.7.2.

Time jitter

– Depress push-button DC of the signal-coupling controls
– Depress push-button DEL'D TB of the horizontal-deflection controls
– Set the MAIN TIME/DIV switch to 1 ms and the DEL'D TIME/DIV switch to 1 μs
– Adjust the LEVEL potentiometer of the main time-base generator for a stable, triggered display
– Check that the time jitter does not exceed 0,3 DIV
– Depress push-button TRIG of the del'd tb trigger-mode controls
– Check that a jitter-free display can be obtained by adjusting the LEVEL control of the delayed time-base

3.4.1.6. X Deflection

D.C. Balance

– Depress push-button MAIN TB of the horizontal-deflection controls
– Set the X POSITION potentiometer to such a position that the starting point of the time-base line coincides with the left-hand vertical graticule line
– Depress push-button EXT X DEFL of the horizontal-deflection controls
– Check that the spot does not move more than 0,3 DIV when the X AMPL potentiometer is turned clockwise or anti-clockwise; if necessary, readjust in accordance with chapter 3.4.2.8.1.

X Deflection via channel A

– Depress push-button B of the display-mode controls
– Set the channel A AMPL switch to 0.5 V/DIV
– Apply a sine-wave signal of exactly 3 V_{p-p}, 2 kHz, to input socket A
– Check that the trace width is exactly 6 DIV
– Check that the control range of the X AMPL control is 1 : 3 to 1 : 4

X Deflection via channel B

– Depress push-button A of the display-mode controls
– Set the AMPL switch of channel B to 0.5 V/DIV
– Depress push-button AC of the channel B signal-coupling controls
– Depress push-button B of the X deflection selector
– Apply a sine-wave voltage of exactly 3 V_{p-p}, 2 kHz, to input socket B
– Check that the trace width is 6 DIV, ±0,5 DIV

External X deflection

– Depress push-button EXT of the X deflection selector
– Turn the X AMPL potentiometer fully clockwise
– Apply a sine-wave voltage of exactly 2,4 V_{p-p}, 2 kHz, to the EXT input socket
– Check that the trace width is 8 DIV, ±1,5 DIV

Bandwidth

– Depress push-button A of the X deflection selector
– Apply a sine-wave signal of exactly 4,5 V_{p-p}, 2 kHz, to input socket A
– Depress push-button B of the display-mode controls
– Check that the trace width is 9 DIV
– Increase the frequency of the input signal to 2 MHz
– Check that the trace width is at least 6,3 DIV

Phase difference

– Depress the CHOP push-button of the display-mode controls
– Depress push-buttons NORM of the signal-polarity controls
– Set the AMPL switches to 5 mV/DIV
– Depress the DC push-buttons of the signal-coupling controls
– Depress push-button B of the X deflection selector
– Apply a sine-wave voltage of 30 mV_{p-p}, 0,1 MHz, to both input socket A and input socket B
– Check that the phase difference does not exceed 3^{o}

X Deflection with internal voltage at mains frequency

– Depress push-button MAINS of the X deflection selector
– Set the mains voltage to 220 V
– Check that the trace width is 8 DIV, ±1,5 DIV; if necessary, readjust in accordance with section 3.4.2.8.3.

3.4.1.7. Calibration unit

– Check the CAL voltage for irregularities
– Check that the amplitude of the square-wave voltage is 3 V_{p-p}, ±0,7 %
– Check that the frequency is 2 kHz, ±2 %
– Check that the CAL current is 6 mA, ±1 %

If the requirements stated above are not met, readjust the calibration unit in accordance with section 3.4.2.10.

3.4.2. Adjusting procedure

3.4.2.1. General information

The following information provides the complete checking and adjusting procedure for the PM 3260 oscilloscope. As various control functions are interdependent, a certain order of adjustment is often necessary. The procedure is, therefore, presented in a sequence which is best suited to this order, cross-reference being made to any circuit which may affect a particular adjustment. Before any check or adjustment, the instrument must attain its normal operating temperature. Under average conditions this will be approximately 30 minutes after switching on.

All controls which are mentioned without item numbers are located on the front panel of the oscilloscope.

3.4.2.2. Recommended test equipment

Digital multimeter, e.g. PHILIPS type PM 2421 or PM 2422A.
Pulse generator, rise time ⩽ 200 ns, e.g. PHILIPS type PM 5711 or PM 5775/76.
Pulse generator, rise time ⩽ 1 ns, e.g. Tektronix type 106 or 284.
Constant amplitude signal generator, e.g. Tektronix type 067.0532.01.
R.C. Standardizer, 1 MOhm//15 pF, e.g. Tektronix type 067.0537.00.
Time-marker generator, e.g. Tektronix type 2901.
Oscilloscope with differential input facility e.g. PM 3210.

3.4.2.3. Preliminary control settings

- Depress push-buttons NORM of the polarity controls.
- Depress push-buttons DC of the signal-coupling controls.
- Set the DELAY TIME control to 0 (fully anti-clockwise).
- Depress push-button MAIN TB of the horizontal-deflection controls.
- Push the TB MAGN control to position x1.
- Depress push-buttons START and AUTO of the trigger-mode controls.
- Set the MAIN TIME/DIV switch to 1 ms and the DEL'D TIME/DIV switch to OFF.
- Set the continuous TIME/DIV controls to CAL.
- Depress push-buttons DC of the trigger-coupling controls.
- Depress push-buttons A of the trigger-source controls.

3.4.2.3.1. If necessary, check the power supply voltages first, refer to 3.4.2.9.

3.4.2.4. Cathode-ray tube circuit

3.4.2.4.1. Focus and astigmatism

- Depress push-button A of the display-mode controls.
- Depress push-button MAIN TB of the horizontal-deflection controls.
- Apply a sine-wave signal at a frequency of 100 kHz to input A.
- Adjust the display height to 6 DIV, using the AMPL switch and vernier.
- Set the MAIN TIME/DIV switch and the LEVEL potentiometer to such a position that several complete cycles are displayed.
- Set the INTENS potentiometer for normal brilliance.
- Check that a reasonably sharp trace can be obtained with the aid of the FOCUS potentiometer. If necessary, readjust potentiometer R579 (ASTIGM.) on the H.T. converter board (Fig. 3.11).
- Increase the trace brilliance using the INTENS potentiometer.
- Check that still a sharp trace can be obtained with the aid of the FOCUS potentiometer.

3.4.2.4.2. Brilliance

- Depress push-button A of the display-mode controls.
- Depress push-button DEL'D TB of the horizontal-deflection controls.
- Turn the INTENS potentiometer clockwise.
- Set the MAIN TIME/DIV switch to 1 ms and the DEL'D TIME/DIV switch to 1 μs
- Depress push-button 0 of the signal-coupling controls.
- Check that a dot at the start of the trace is just visible.
  If necessary, readjust potentiometer R547 (INTENSITY) on the horizontal output-amplifier and Z amplifier circuit board (Fig. 3.12.).
- Set the MAIN TIME/DIV switch to 0.05 μs and the DEL'D TIME/DIV switch to OFF.
- Depress push-button MAIN TB of the horizontal-deflection controls.
- Pull the TB MAGN switch to x10.
- Set the INTENS potentiometer for normal brilliance.
- Check that the brilliance is uniform over the entire trace.
  If necessary, readjust trimmer C509 (BLANK. PULSE) located on the horizontal output-amplifier and Z-amplifier circuit board.

3.4.2.4.3. Brilliance ratio

- Depress push-button A of the display-mode controls.
- Depress push-button MAIN TB of the horizontal-deflection controls.
- Turn the DELAY TIME control to 5.0 (mid-position).
- Set the MAIN TIME/DIV switch to 1 ms and the DEL'D TIME/DIV switch to .2 ms.
- Depress push-button AC of the signal-coupling controls.
- Apply a sine-wave signal at a frequency of 100 kHz to input A.
- Set the display height to 6 DIV.
- Set the INTENS potentiometer to a position 90^{o} from the anti-clockwise stop; see Fig. 3.13.
- Check that the trace of the main time-base generator is just visible over the entire screen and that the part determined by the delayed time-base generator is more brilliant. If necessary, readjust the INTENS RATIO potentiometer R1498 on the X deflection selection circuit board (Fig. 3.14.).

3.4.2.4.4. Trace rotation

- Depress push-button A of the display-mode controls.
- Depress push-button MAIN TB of the horizontal-deflection controls.
- Centre the time-base line, using the POSITION controls.
- Check that the time-base line runs exactly in parallel with the horizontal lines of the graticule; if necessary, readjust TRACE ROT potentiometer R589 on the intermediate amplifier circuit board (Fig. 3.15.).

3.4.2.4.5. Shift correction

- Depress push-button A of the display-mode controls.
- Depress push-button MAIN TB of the horizontal-deflection controls.
- Connect a d.c. voltmeter to the vertical-deflection plates (test points A in Fig. 3.12).
- Set the channel A POSITION potentiometer to obtain a voltage of 0 V (±300 mV) between the deflection plates.
- Check that the time-base line is displayed exactly in the centre of the screen; if necessary, readjust SHIFT CORR. potentiometer R588 on the intermediate-amplifier circuit board (Fig. 3.15).

3.4.2.4.6. Orthogonality

- Depress push-button ALT of the display-mode controls.
- Depress push-button MAIN TB of the horizontal-deflection controls.
- Depress push-button 0 of the channel A signal-coupling controls.
- Set the MAIN TIME/DIV switch to 1 ms and the DEL'D TB switch to 5 μs.
- Set the channel B AMPL switch to 5 mV/DIV and its vernier control to CAL.
- Apply a sine-wave voltage of 120 mV, frequency 100 kHz, to input B.
- Centre the intensified part, using the DELAY TIME control.
- Centre the channel A time-base line, using the channel A POSITION potentiometer.
- Check that the angle between the horizontal and vertical line is 90^{o} see Fig. 3.16. If necessary, readjust X-Y CORR potentiometer R587 on the intermediate-amplifier board (Fig. 3.15).
- Check also trace rotation (chapter 3.4.2.4.4.).

3.4.2.4.7. Geometry (= Barrel and pin cushion distortion)

- Depress push-button A of the display-mode controls.
- Depress push-button MAIN TB of the horizontal-deflection controls.
- Apply a sine-wave voltage at a frequency of approx. 100 kHz to input A.
- Set the AMPL controls to obtain a display height of 7,4 DIV.
- Apply a sine-wave voltage at a frequency of approx. 50 Hz to input B.
- Depress push-button EXT X DEFL of the horizontal-deflection controls.
- Depress push-button B of the main time-base trigger-source controls.
- Set the channel B AMPL switch and the X AMPL control to obtain a display width of 9,4 DIV.
- Check that the edges of the display lie within the hatched area shown in Fig. 3.17.; if necessary, readjust the GEOMETRY potentiometer R568 on the H.T. converter board (Fig. 3.11.).

3.4.2.5. Vertical deflection

3.4.2.5.1. Gain

- Depress push-button A (B) of the display-mode controls.
- Depress push-button NORM of the polarity controls.
- Set the AMPL switch to .5 V/DIV.
- Set the AMPL vernier control to CAL.
- Depress push-button DC of the signal-coupling controls.
- Apply a square-wave voltage with an amplitude of exactly 3 V to input A (B).
- Check that the display height is exactly 6 DIV. If necessary, check that the display height is more than 6,7 to 7 DIV with gain control completely clockwise.
  For gain control adjustments refer to chapter 3.4.2.5.3. and Fig. 3.20.
- Check that the control range of the AMPL vernier control is at least 1:2,5.

3.4.2.5.2. Balance

1. D.C. Balance

- Depress push-button A (B) of the display-mode controls.
- Centre the time-base line, using the POSITION control.
- Turn the AMPL switch between 20 mV/DIV and 5 mV/DIV.
- Check that the trace does not jump more than 0,3 DIV; if necessary, adjust the BAL control on the front panel.

2. Gain balance

Before adjusting the Gain Balance, first check D.C. Balance.

- Rotate the AMPL vernier control between maximum and minimum.
- Check that during this procedure the time-base line does not shift more than 0,3 DIV; if necessary, readjust GAIN BAL potentiometer R361 (R311) on the intermediate-amplifier board, Fig. 3.15 (Fig. 3.18).

3. Polarity balance

Before adjusting the Polarity Balance, the D.C. Balance and the Gain Balance must be adjusted in accordance with both previous sections.

- Check that the time-base line does not shift more than 0,3 DIV when push-button INVERT of the polarity controls is depressed; if necessary, readjust POL BAL potentiometer R383 (R333) on the intermediate-amplifier board, Fig. 3.15 (Fig. 3.18).

3.4.2.5.3. Frequency response (and gain) of vertical amplifiers

In the following section the three stages are checked in the sequence: Final Y amplifier, Intermediate amplifier, Attenuators.
For adjustment of the final Y amplifier first the output voltage of the channel-selector chopper is used as a calibration signal. The channel selector is controlled by an external square-wave generator (50 % duty cycle) with variable frequency, which is connected to the ALT control socket on the intermediate amplifier circuit board.
Later on, the final Y amplifier, in combination with intermediate amplifier and attenuators is calibrated with the aid of a pulse with a rise-time of $\leqslant$ 1 ns.

1. Final Y amplifier

For good h.f. response check also the filter-coils which are mounted on the c.r.t. Y deflection pins (check the pins on clean contact).

- Depress push-button ALT of the display-mode controls.
- Set the POSITION controls to obtain a distance of 6 DIV between both time-base lines.
- Remove the main-time base connector from the alternate control-pulse socket on the intermediate-amplifier board (socket A in Fig. 3.18).
- Connect the square-wave generator to the alternate-pulse socket A via a 330-Ω-resistor.
- Set the output voltage of the square-wave generator to approx. 1 V positive.
- Trigger the oscilloscope externally with the same signal.
- Both time-base lines will be displayed alternately at a frequency determined by the frequency of the square-wave voltage.

1 kHz, R407 (Fig. 3.19)

– Set the generator frequency to 1 kHz.
– Set the main-time base controls to obtain a suitable, triggered display, see Fig. 3.20.
– Check that the top of the displayed pulse is straight; if necessary, select a different value for resistor R407 (typical value 10 kΩ).

Before proceeding with the other frequency corrections, the gain must be adjusted as follows:

– Set the AMPL vernier controls to CAL.
– Connect an oscilloscope with differential input, to the output pins B of the intermediate amplifier (Fig. 3.15); do not disconnect the delay line.
– The output voltage of the intermediate amplifier is now displayed on the auxiliary oscilloscope.
– Adjust the POSITION controls of the oscilloscope under test to obtain a voltage reading of 496 mV on the auxiliary oscilloscope (496 mV = 8x62 mV refer to Fig. 3.21).
– Check that the distance between both time-base lines of the oscilloscope under test is 8 DIV; if necessary, readjust GAIN potentiometer R432 (Fig. 3.19) on the final-amplifier board.

10 kHz, R403, C402 (Fig. 3.19)

– Set the generator frequency to 10 kHz.
– Set the main-time base controls to obtain a suitable, triggered display.
– Check that the top of the displayed pulse is straight; if necessary, select different values for resistor R403 and capacitor C402.
(typical values: R403 = 4 kΩ; C402 = 2700 pF).

100 kHz, R404, C403 (Fig. 3.19)

– Set the generator frequency to 100 kHz.
– Set the main-time base controls to obtain a suitable, triggered display.
– Check that the top of the displayed pulse is straight; if necessary, select different values for resistor R404 and capacitor C403.
(typical value: R404 = 2700 Ω, C403 = 1500 pF).

1 MHz, R406, C404 (Fig. 3.19)

– Remove the external generator.
– Depress push-button CHOP of the display-mode controls.
– Centre both time-base lines to obtain one line.
– Reconnect the ALT control-pulse plug to its relevant socket.
– Trigger the oscilloscope externally with the chopper signal available on point 8 of IC1602.
– Set the main time-base controls to obtain a suitable triggered display.
– Check that the displayed line is straight; if necessary, select different values for resistor R406 and capacitor C404.
(typical values: R406 = 500 Ω; C404 = 150 pF).
Reconnect the original connections.

2. Intermediate amplifier

To be sure that the intermediate amplifier is driven by the correct signal, the attenuator is checked first.

– Depress push-button NORM of the polarity controls.
– Depress push-button DC of the signal-coupling controls.
– Set the AMPL vernier control to CAL.
– Set the AMPL switch to 10 mV/DIV.
– Apply a square-wave voltage with a rise time $\leqslant$ 1 ns and a frequency of approx. 20 kHz to input A (B).
– Set the amplitude of the input signal to obtain a trace height of 6 DIV.
– Connect an oscilloscope to the attenuator output: point 12 of IC352 (IC302).
– Check that the top of the displayed pulse is straight; if necessary, readjust trimmer C108 (C308) on the attenuator board (Fig. 3.15).

1 kHz, R364, C357 (R314, C307) Fig. 3.15 (Fig. 3.18)

– Set the generator frequency to 1 kHz.
– Check that the top of the displayed pulse is straight; if necessary, select different values for resistor R364 (R314) and capacitor C357 (C307).

Before proceeding with the other frequency corrections, the gain must be adjusted as follows:
– Set the AMPL vernier control to CAL.
– Set the amplitude of the input signal to 30 mV.
– Check that the trace height is 6 DIV; if necessary, readjust the GAIN potentiometer on the front panel.

10 kHz, R366, C358//C359 (R316, C308//C309), Fig. 3.15 (Fig. 3.18)

– Set the generator frequency to 10 kHz.
– Check that the top of the displayed pulse is straight; if necessary, select different values for resistor R366 (R316) and capacitor C358//C359 (C308//C309).

100 kHz, R373, C371 (R323, C321), Fig. 3.15 (Fig. 3.18)

– Set the generator frequency to 100 kHz.
– Check that the top of the displayed pulse is straight; if necessary, select different values for resistor R373 (R323) and capacitor C371 (C321).

1 MHz, C356, C372 (C306, C322), Fig. 3.15 (Fig. 3.18)

– Set the generator frequency to 1 MHz.
– Check that the top of the displayed pulse is straight; if necessary, select different values for capacitors C356 and C372 (C306 and C322).

3. **H.F. Response**

1 MHz, R368 (R318) Fig. 3.15 (Fig. 3.18), R408, R409, R410, C407, Fig. 3.19

– Depress push-button A (B) of the display-mode controls.
– Depress push-button NORM of the polarity controls.
– Set the AMPL switch to 10 mV/DIV.
– Apply a square-wave voltage with a rise time of $\leqslant$ 1 ns and a frequency of 1 MHz to input A (B).
– Set the MAIN TIME/DIV switch to 0.1 μs.
– Pull the TB MAGN switch to x10.
– Check that there is an optimum pulse response; if necessary, select different values for the h.f. correction elements R368 (channel A) and R318 (channel B) of the intermediate amplifier, and R408, 409, 410 and C407 of the final amplifier, at the same time readjusting TERMINATION potentiometer R423 (Fig. 3.19).
– Repeat the adjustments until optimum pulse responses for both channel A and channel B are obtained.
– Check that the rise time is less than 3 ns; if necessary, readjust potentiometer R408 in conjunction with h.f. correction potentiometer R368 (for channel A) and R318 (for channel B) on the intermediate amplifier board.

After this adjustment check the gain as follows:
– Set the generator frequency to 1 kHz.
– Set the generator output voltage to 30 mV.
– Check that the trace height is 6 DIV, if necessary, readjust potentiometer R432 on the final Y amplifier board (Fig. 3.19).

4. **Attenuator**

– Depress push-button A (B) of the display-mode controls.
– Depress push-button NORM of the polarity controls.
– Depress push-button DC of the signal-coupling controls.
– Apply a square-wave voltage with a rise time $\leqslant$ 200 ns and a frequency of 20 kHz to input A (B).

Frequency compensation

– Set the AMPL switch to the positions indicated in the following table, at the same time setting the input amplitude to the appertaining values.
– Check that there is an optimum display of the input signal; if necessary, readjust the relevant trimmer.

AMPL switch to	Signal at input A (B)	Adjust with (Fig. 3.15; Fig. 3.18)
10 mV/DIV	Already adjusted (C108) in intermediate amplifier adjustment; refer to 3.4.2.5.3.2.	
.1 V/DIV	600 mV	C101
1 V/DIV	6 V	C109

Input capacitance

- Apply the square-wave input voltage (rise time ⩽ 200 ns, frequency 20 kHz) to input A (B) via an RC Standardizer of 1 MOhm//15 pF.
- Set the AMPL switch to the positions indicated in the following table, at the same time setting the input amplitude to the appertaining values.
- Check that there is an optimum display of the input signal; if necessary, readjust the relevant trimmer.

AMPL switch to	Signal at input A (B)	Adjust with (Fig. 3.15; Fig. 3.18)
10 mV/DIV	60 mV	C107
.1 V/DIV	600 mV	C102
1 V/DIV	6 V	C111

3.4.2.5.4. Chopping

- Depress push-button CHOP of the display-mode controls.
- Depress push-button MAIN TB of the horizontal-deflection controls.
- Set the MAIN TIME/DIV switch to 0.2 μs.
- Check that there are two time-base lines displayed which can be shifted in relation to one another by means of the POSITION controls.
- Set the POSITION potentiometers to obtain a distance of 3 DIV between the two lines.
- Depress push-button EXT of the main time-base trigger-source controls.
- Apply the chopper signal (available at point 8 of IC1601 on the intermediate amplifier circuit board) to the EXT input of the main time-base. It is then possible to trigger the time-base generator with the chopper frequency.
- Set the LEVEL potentiometer for a triggered display.
- Check that the chopper frequency is approx. 1 MHz.
- Check that each signal is displayed for approx. 300 ns.
- Check that the trace is blanked during the channel-switching.
- Check that the blanking time is approx. 200 ns.

3.4.2.6. Triggering

When checking and adjusting the trigger amplifiers, bear in mind that the various trigger circuits are interdependent as shown in the block diagram.

3.4.2.6.1. Trigger amplifiers (channels A and B) on intermediate amplifier circuit board

1. Shift

- Depress push-button 0 of the channel A (B) signal-coupling controls.
- Measure the voltage between points C and D (A and B) see Fig. 3.15 (Fig. 3.18).
- Check that the voltage is 0 V ± 10 mV; if necessary, readjust SHIFT potentiometer R351 (R301).

2. Zero level

Before checking the zero level, the trigger amplifier must be checked in accordance with the previous section (p.1.).

- Depress push-button 0 of the channel A (B) signal-coupling controls.
- Measure the voltage between point D (B) and earth (Fig. 3.15; Fig. 3.18).
- Check that the measured voltage is 0 V ± 10 mV; if necessary, readjust ZERO level potentiometer R354 (R304).

3.4.2.6.2. Trigger amplifier of the main time-base

Before checking and adjusting the trigger amplifier of the main time-base, the trigger amplifiers of channels A and B must be checked in accordance with section 3.4.2.6.1.

1. Level

- Depress push-button MAIN TB of the horizontal-deflection controls.
- Depress push-buttons 0 of the signal-coupling controls.
- Depress push-button HF of the trigger-coupling controls.
- Connect test point C, Fig. 3.22 (base of TS637) to earth.
- Measure the voltage on point D, Fig. 3.22 (point 4 of IC601) with respect to earth.
- Check that the measured voltage is 9 to 10 V, and does not change when the SLOPE switch of the main time-base is set from + to –; maximum allowable deviation is 100 mV. If necessary, readjust LEVEL potentiometer R709 (Fig. 3.22).
- Depress push-button DC of the trigger-coupling controls.
- Depress push-button A (B) of the trigger-source controls.
- Check that the voltage on test point D of the main time-base board does not change when the SLOPE switch is set from + to –; maximum allowable deviation is 100 mV. If necessary, readjust YA (YB) potentiometer R636 (R656), Fig. 3.22.
- Depress push-button EXT of the trigger-source controls.
- Check that the voltage on test point D of the main time-base board does not change when the SLOPE switch is set from + to –; maximum allowable deviation is 100 mV. If necessary, readjust EXT potentiometer R631 (Fig. 3 22).
- Remove earth connection from testpoint C.

2. L.F. Gain

This control (R712) equalizes the gain of the lf- and hf path of the trigger amplifier circuit. In this procedure a signal is applied to the channel A input, while the signal in the trigger circuit is shown on channel B.

- Depress push-button B of the display-mode controls.
- Depress push-button NORM of the polarity controls.
- Depress push-button DC of the channel A signal-coupling controls.
- Depress push-button AC of the channel B signal-coupling controls.
- Depress push-button A of the trigger-source controls.
- Set the AMPL switch of channel A to 20 mV/DIV and the AMPL switch of channel B to 0.1 V/DIV.
- Apply a square-wave voltage of 120 mV, frequency 30 kHz, to input A.
- Apply the signal at test point A (TS634) or B (TS642) to channel B input.
- Set the LEVEL control on the front panel for maximum signal to channel B.
- Check that the top of the displayed pulse is straight; if necessary, readjust LF GAIN potentiometer R712 (Fig. 3.22).
- Depress push-button LF of the trigger-coupling controls.
- Check that the displayed pulse is shaped as shown in Fig. 3.23.
- Depress push-button HF of the trigger-coupling controls.
- Check that the displayed pulse is shaped as shown in Fig. 3.24.

3. Trigger sensitivity (gain)

- Depress push-button A of the display-mode controls.
- Set the AMPL switch to 20 mV/DIV.
- Depress push-button AC of the signal-coupling controls.
- Depress push-button DC of the trigger-coupling controls.
- Apply a sine-wave voltage of 120 mV (2 kHz) to input A.
- Check that the starting point of the displayed sine-wave does not move when the SLOPE switch is set from + to –; if necessary, readjust TRIG SENS potentiometer R737 on the main time-base board (Fig. 3.22).

3.4.2.6.3. Trigger amplifier of the delayed time-base

1. Level

- Depress push-button DEL'D TB of the horizontal-deflection controls.
- Depress push-buttons 0 of the signal-coupling controls.
- Depress push-buttons HF of the del'd tb trigger-coupling controls.
- Connect test point C', Fig. 3.22 (base of TS1037) to earth.
- Measure the voltage on point D', Fig. 322 (point 4 of IC1001) with respect to earth.
- Check that the measured voltage is 9 to 10 V and does not change when the SLOPE switch of the delayed time-base is set from + to −; maximum allowable deviation is 100 mV. If necessary, readjust LEVEL potentiometer R1109 (Fig. 3.22).
- Depress push-button DC of the trigger-coupling controls.
- Depress push-button A (B) of the trigger-source controls.
- Check that the voltage on test point D' of the delayed time-base board does not change when the SLOPE switch is set from + to −; maximum allowable deviation is 100 mV. If necessary, readjust YA (YB) potentiometer R1036 (R1056), Fig. 3.22.
- Depress push-button EXT of the trigger-source controls.
- Check that the voltage on test point D' does not change when the SLOPE switch is set from + to −; maximum allowable deviation is 100 mV. If necessary, readjust EXT potentiometer R1031 (Fig . 3.22).
- Remove earth connection from test point C'.

2. L.F. Gain

This control (R1112) equalizes gain of the lf- and hf path of the trigger amplifier circuit. In this procedure a signal is applied to the channel A input while the signal in the trigger circuit is shown on channel B.

- Depress push-button B of the display-mode controls.
- Depress push-button NORM of the polarity controls.
- Depress push-button DC of the channel A signal-coupling controls.
- Depress push-button AC of the channel B signal-coupling controls.
- Depress push-button A of the trigger-source controls of the delayed-time base.
- Set the AMPL switch of channel A to 20 mV/DIV and the AMPL switch of channel B to 0.1 V/DIV.
- Apply a square-wave voltage of 120 mV, frequency 30 kHz, to input A.
- Apply the signal at testpoint A (TS1042) or B (TS1034) to the channel B input.
- Set LEVEL control on the front panel for maximum signal to channel B.
- Check that the top of the displayed pulse is straight; if necessary, readjust LF GAIN potentiometer R1112 (Fig. 3.22).
- Depress push-button LF of the trigger-coupling controls of the delayed time-base.
- Check that the displayed pulse is shaped as shown in Fig. 3.23.
- Depress push-button HF of the trigger-coupling controls.
- Check that the displayed pulse is shaped as shown in Fig. 3.24.

3. Trigger sensitivity (gain)

- Depress push-button A of the display-mode controls.
- Set the AMPL switch to 20 mV/DIV.
- Depress push-button AC of the signal-coupling controls.
- Depress push-button DC of the trigger-coupling controls of the delayed time-base.
- Depress push-button DEL'D TB of the horizontal-deflection controls.
- Depress push-button TRIG of the trigger-mode controls of the delayed time-base.
- Set the MAIN TIME/DIV switch to 20 μs and the DEL'D TIME/DIV switch to 10 μs.
- Apply a sine-wave voltage of 120 mV to input A.
- Check that the starting point of the displayed sine-wave does not move when the SLOPE switch is set from + to −; if necessary, readjust TRIG GAIN potentiometer R1137 on the delayed time-base board (Fig. 3.22).

3.4.2.7. Sweep circuits

3.4.2.7.1. Main time-base

1. Stability

- Depress both 0 push-buttons of the signal-coupling controls.
- Depress push-button MAIN TB of the horizontal-deflection controls.
- Depress push-button TRIG of the trigger-mode.
- Set the DEL'D TIME/DIV switch to OFF.
- Rotate the LEVEL control fully anti-clockwise.
- Turn STAB potentiometer R806 fully clockwise (Fig. 3.22).
- Rotate STAB potentiometer R806 approx. 20° past the point where the time-base line ceases to be displayed.
- Depress push-button AUTO of the trigger-mode and check if the sweep circuit is running.

2. Time coefficients

As the power supply may affect the sweep times, it must be checked when the sweep times are not correct.

- Connect a time-marker generator to a Y input socket.
- Depress push-button MAIN TB of the horizontal-deflection controls.
- Push the TB MAGN control to position x1.
- Set the MAIN TIME/DIV switch to 0.1 ms.
- Apply a time-marker signal of 0.1 ms.
- Check that the 8 centre cycles cover exactly 8 DIV; if necessary, readjust X1 potentiometer R1462 (Fig. 3.14).
- Pull the TB MAGN control to position x10.
- Set the time-marker generator to 10 μs.
- Check that the 8 centre cycles cover exactly 8 DIV; if necessary, readjust X10 potentiometer R1444 (Fig. 3.14.).
- Set the MAIN TIME/DIV switch to 10 ms.
- Push the TB MAGN control to position x1.
- Set the time-marker generator to 10 ms.
- Check that for the 8 centre cycles a display of one cycle per DIV is obtained; if necessary, readjust 10 ms potentiometer R834 (Fig. 3.22).
- Check the sweep times in all other positions of the MAIN TIME/DIV switch; tolerance ± 2 % in temperature range +20 °C to +30 °C.

3. Linearity

- Depress push-button MAIN TB of the horizontal-deflection controls.
- Pull the TB MAGN control to position x10.
- Depress push-button AUT of the trigger-mode controls.
- Set the MAIN TIME/DIV switch to 0,05 μs.
- Set the time-marker generator to 10 ns.
- Check that the 4 centre cycles cover exactly 8 DIV; if necessary, readjust trimmers C1703 and C1707 (Fig. 3.12.).

3.4.2.7.2. Delayed time-base

1. Stability

- Depress push-button 0 of the signal-coupling controls.
- Rotate the DELAY TIME control fully anti-clockwise.
- Depress push-button DEL'D TB of the horizontal-deflection controls.
- Depress push-button TRIG of the del'd tb trigger-mode controls.
- Depress push-button AUTO of the trigger-mode controls.
- Set the MAIN TIME/DIV switch to 0.2 ms and the DEL'D TIME/DIV switch to 0.1 ms.
- Rotate the del'd tb LEVEL control fully anti-clockwise.
- Rotate STAB potentiometer R1206 on the delayed time-base board fully anti-clockwise (Fig. 3.22).
- Rotate STAB potentiometer R1206 approx. 20° past the point where the time-base line ceases to be displayed.

2. Time coefficients

- Connect a time-marker generator to the channel A input.
- Rotate the DELAY TIME control fully anti-clockwise (delay time minimum).
- Depress push-button DEL'D TB of the horizontal-deflection controls.
- Depress push-button TRIG of the del'd tb trigger-mode controls.
- Depress push-button AUTO of the trigger-mode controls.
- Set the MAIN TIME/DIV switch to 0.2 ms and the DEL'D TIME/DIV switch to 0.1 ms.
- Depress push-button DC of the del'd tb trigger-coupling controls.
- Depress push-button A of the del'd tb trigger-source controls.
- Apply a time-marker signal of 0.1 ms.
- Check that the 8 centre cycles cover exactly 8 DIV; if necessary, readjust 0.1 ms potentiometer R1227 (Fig. 3.22).
- Set the MAIN TIME/DIV switch to 20 ms and the DEL'D TIME/DIV switch to 10 ms.
- Set the time-marker generator to 10 ms.
- Check that the 8 centre cycles cover exactly 8 DIV; if necessary, readjust 10 ms potentiometer R1234 (Fig. 3.22).
- Check the sweep times in all other positions of the DEL'D TIME/DIV switch; tolerance ±2 % in temperature range +20 °C to +30 °C. Keep during this check the DELAY TIME control fully anti-clockwise and the MAIN TIME/DIV switch one position slower than the DEL'D TIME/DIV switch. In this way, the delayed time-base can complete an entire sweep.

3. Delay-time

This procedure only applies to the standard model PM 3260 and not to the PM 3260E model.

- Depress push-button A of the display-mode controls.
- Depress push-button DC of the signal-coupling controls.
- Depress push-button MAIN TB of the horizontal-deflection controls.
- Depress push-buttons AUTO and STARTS of the trigger-mode controls.
- Set the MAIN TIME/DIV switch to 0.1 ms and the DEL'D TIME/DIV switch to 0.05 μs.
- Depress push-button DC of the trigger-coupling controls.
- Depress push-button A of the trigger-source controls.
- Apply a time-marker of 0,1 ms.
- Set the DELAY TIME control to 1.00.
- Check that the spot of the delayed time-base coincides with the starting point of the second time-marker pulse; if necessary, readjust START potentiometer R1514 on the switching-unit board (Fig. 3.14).
- Set the DELAY TIME control to 9.00.
- Check that the spot of the delayed time-base coincides with the starting point of the tenth time-marker pulse; if necessary, readjust STOP potentiometer R1513 on the switching-unit board (Fig. 3.14.).

As the START and STOP adjustments are slightly interdependent, they must be repeated until both conditions are fulfilled.

3.4.2.8. Horizontal deflection

3.4.2.8.1. Balance of the horizontal amplifier

If necessary, first check trigger amplifiers on the intermediate amplifier circuit board.

- Depress push-button MAIN TB of the horizontal-deflection controls.
- Push the TB MAGN control to X1.
- Set the X POSITION control to such a position, that the time-base line starts at the first vertical graticule line.
- Depress push-button EXT X DEFL of the horizontal-deflection controls.
- Depress push-button A of the X deflection-source controls.
- Check that the spot does not move more than 0.3 DIV when the X AMPL potentiometer is rotated clock-wise and anti-clockwise; if necessary, readjust POS potentiometer R1401 on the switching-unit board (Fig. 3.14).
- Check that after this adjustment the spot lies within one DIV from the screen centre.

3.4.2.8.2. X Deflection via channel A

- Depress push-button B of the display-mode controls (the vertical A channel is now blocked).
- Set the channel A AMPL switch to 0.5 V/DIV.
- Depress push-button AC of the signal-coupling controls.
- Depress push-button EXT X DEFL of the horizontal-deflection controls.
- Depress push-button A of the X deflection-source controls.
- Apply a sine-wave voltage of exactly 3 $V_{p\text{-}p}$, frequency 2 kHz to input A.
- Check that the trace length is exactly 6 DIV; if necessary, readjust GAIN potentiometer R1419 on the switching-unit board (Fig. 3.14).

3.4.2.8.3. X Deflection with the mains frequency

- Depress push-button EXT X DEFL of the horizontal-deflection controls.
- Depress push-button MAINS of the X deflection-source controls.
- Check that the trace width is 8 DIV ± 1,5 DIV; (mains voltage 220 V) if necessary, readjust potentiometer R669 on the main-time base circuit board, Fig. 3.22. (in instruments of the −/01 model, this potentiometer is located on the power supply circuit board, R1838, Fig. 3.25).

3.4.2.9. Power supply

Warning: Use an isolating mains transformer when working in the power supply unit.
Bear in mind that the main part of this unit is connected direct to the mains.
As it is preferred to check the proper function of the power supply with adjustable mains voltage, use of a variable transformer (insulated version) is recommended.

Attention: The power supply unit is provided with one pre-set potentiometer R1828 Fig. 3.25, which controls the d.c. output of the circuit. DO NOT READJUST THIS POTENTIOMETER UNLESS IT IS STRICTLY NECESSARY.
A consequence of readjusting this potentiometer is that all d.c. output voltages change, so that several circuits of the oscilloscope (e.g. time base sweep) must be recalibrated.
In the factory this potentiometer has been adjusted to the nominal value of the +15 V output (measured on point 6 of the 6-pole connector of the power supply).
This voltage must be +15 V + or −200 mV.

General

The best way to check the power supply is, when this unit is connected to the normal circuitry of the PM 3260. Provisions have been taken that the unit, after being taken out, remains connected to the instrument. To facilitate the removal, first disconnect the various connections of the power supply unit.
For locating a possible overload or short-circuit in the various units of the oscilloscope, the supply connectors of the units may be disconnected, one at the time. Also the supply currents can be measured on each contact of these connectors. To disconnect one contact of a connector carefully press (twice) the spring at the side of the contact and lift the contact out. Inserting an additional contact provided with a piece of extension wire simplifies current measurement. After replacing the original contact check the spring locking-action to prevent the contact from coming loose later-on.

When the power supply unit is overloaded, the current limitation is actuated. As a result of this, the power supply goes in the "hiccup" mode (3-seconds cycle time approx.). This is caused by, successively, slow charging of the capacitors C1808, 1809, starting of the chopper, activiation of current limiting transistor TS1808, discharging of the regulator circuit capacitors and so on.
Another reason for the power supply going in the "hiccup" mode is, when the switching transistor TS1801 gets no base current from the regulator circuit. In this case capacitors C1808, 1809 are slowly charged until the chopper circuit starts which causes the discharge of these capacitors in a short time, and so on.

If necessary, the power supply unit only, can be checked with the aid of a dummy load, consisting of load resistors and capacitors and a 6 V pilot lamp; see Fig. 3.67.
If a fault is suspected in the power supply, the following procedure may help you to find what is wrong.

NOTE: The power supply must always be loaded with the nominal load.

Required instruments

- Variable mains transformer with isolated windings
  (e.g. Philips bench model 2422 529 00005 or
  panel model 2422 529 00006;
  input 220 V, output 0-248 V/3 A).
- Watt meter (to measure mains power input).
- Oscilloscope (5 MHz bandwidth).
- Resistor 100 Ω, 25 W (5322 115 50011).
- Resistor 22 Ω, 25 W (5322 115 50006).
- Resistors of 1 kΩ and 50 kΩ, 0.5 W.

Checking procedure

In the first part of this procedure the power supply circuit is checked while the regulating circuit is out of service. In this case always check that the sum-voltage across C1808 and C1809 never exceeds the sum of the voltages of GR1813 and GR1814.

- Connect the isolating/variable transformer to the mains.
  Connect the power supply in series with a 22 Ω, 25 W resistor, via a Watt meter to the isolating/variable transformer.
  Mains voltage 40 V. Remove current limiting transistor TS1808.
  Check that the sum voltage over C1808, C1809 rises to approx. 56 V within 2 or 3 seconds when the mains voltage is switched-on (the chopper circuit is not oscillating).
  The speed of the charging depends on the current-gain of TS1801.

  If this voltage over C1808, 1809 does not appear check the ripple eliminator circuit (TS1800, TS1805), check R1802 and check the chopper circuit on short-circuit.

- Connect a 1 kΩ resistor in parallel to the series-circuit of C1808, 1809 and check that the sum voltage over these capacitors drops to zero. Remove the 1 kΩ resistor and check that the voltage rises again to 56 V.

- Short circuit emittor-collector of TS1801. Keep the mains voltage on 40 V and start the chopper circuit (TS1803, 1804) by connecting for a short moment the base of TS1803 via a 50 kΩ resistor to point 4 of transformer T1802. The voltage over the 22 Ω resistor in the mains circuit must be approx. 3 V. The voltage over C1808, 1809 is then approx. 35 V.

  If the chopper does not oscillate, check the chopper circuit itself.
  If the chopper goes in the "hiccup" mode when the 50 kΩ resistor remains connected, check the d.c. output circuits of the power supply, and check the circuit connected to points 7 and 8 of T1802.

- Check the voltage on point 5 of T1802 with an oscilloscope.
  This must be a square wave of approx. 70 $V_{p\text{-}p}$, frequency approx. 17 kHz.

- Remove the 22 Ω resistor in the mains circuit.
  Increase the mains voltage until the voltage over C1808, 1809 amounts to 100 V (not higher otherwise the zener diodes GR1813 and 1814 will blow up). The chopper must start automatically.
  Check the pulse on the base of TS1801; the duty cycle of this pulse can be varied with R1828. If not, check the regulator circuit.
  Power consumption must be 45 W approx.

- Remove the short-circuit across TS1802; check that the pulse on the base of TS1801 changes at this moment.

- Fit current limiting transistor TS1808. Check whether the chopper circuit cuts out (goes in the "hiccup" mode) when the load of the power supply is increased by 50 % approx. To this end connect a 100 Ω, 25 W resistor to the +46 V output.
  There must be current limitation when power input exceeds approx. 72 W.
  Also when the +46 V output is short circuited the power supply goes in the "hiccup" mode.

- Mains voltage 90 V; if necessary adjust the +15 V output voltage (+ or − 150 mV tolerance is allowed) with the aid of R1828 (Fig. 3.25).
  Check again the voltage on point 5 of T1801 with an oscilloscope.
  Frequency must be 18 to 22 kHz; check the shape of the chopper square-wave voltage.

- Vary the mains voltage between 90 and 248 V.
  Check that the +15 V output remains constant (between + or − 75 mV).
  Check the 50 % overload current limitation at 248 V (do not short circuit the output at 248 V mains).

3.4.2.10. Calibration unit

- Check the CAL square-wave for irregularities.
- Check that the amplitude is 3 V ± 0.7 %; if necessary, readjust CAL SP potentiometer R1906 Fig. 3.15 on the intermediate-amplifier board.
- Check that the frequency of the CAL voltage is 2 kHz ± 2 %.
- Check that the CAL current is 6 mA ± 1 %.

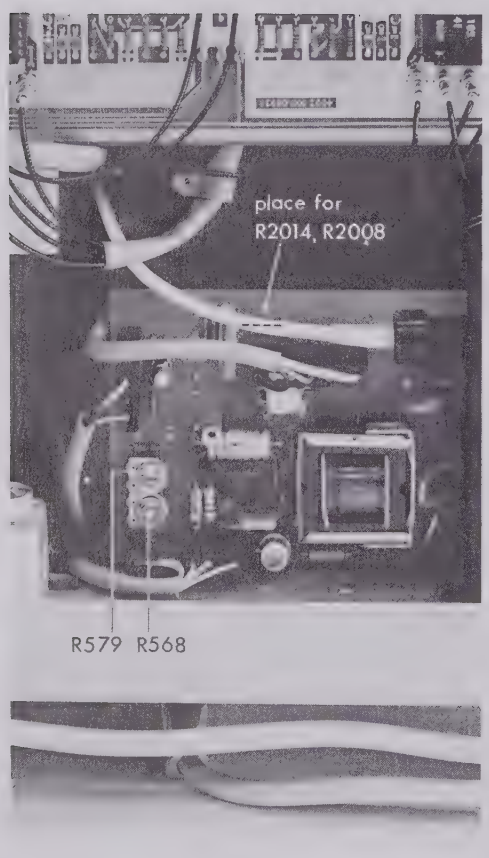


Fig. 3.11.
H.T. Converter board with adjusting references

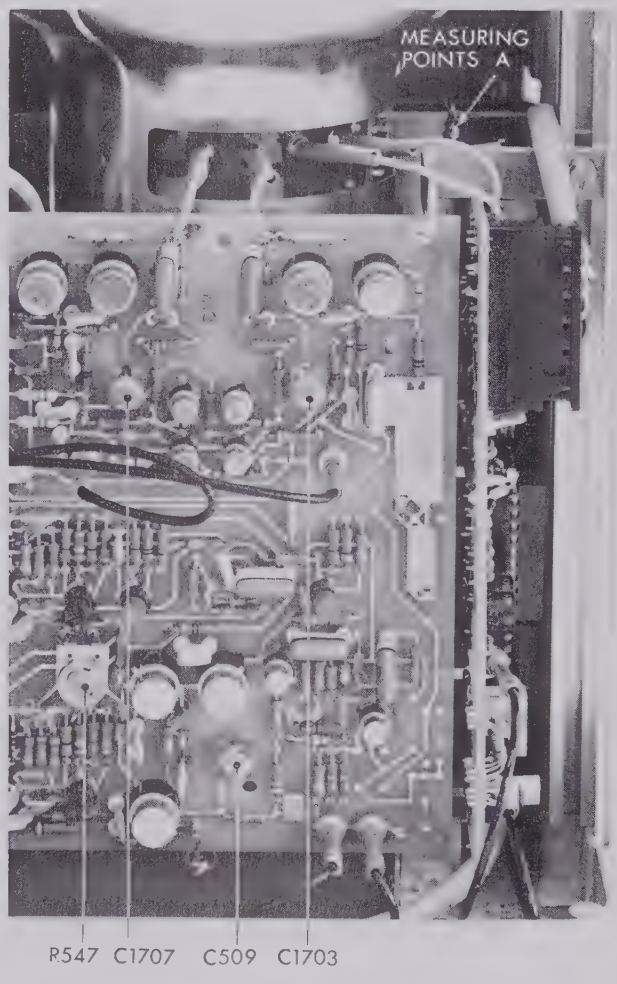


Fig. 3.12.
Final X and Z amplifier board with adjusting references

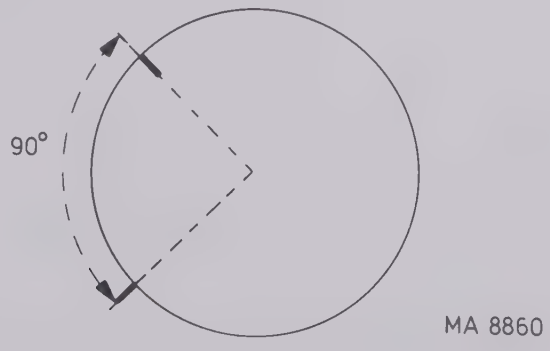


Fig. 3.13. Position of the INTENS potentiometer

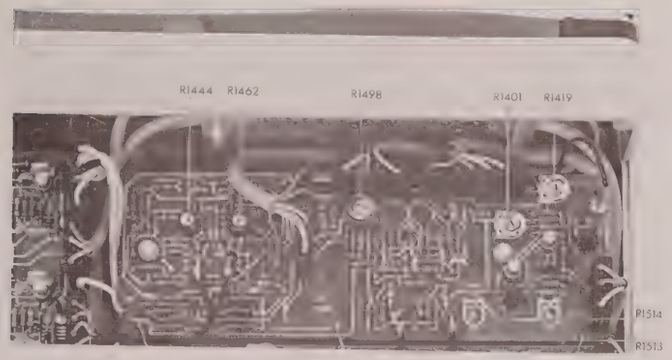


Fig. 3.14. Switching unit with adjusting references

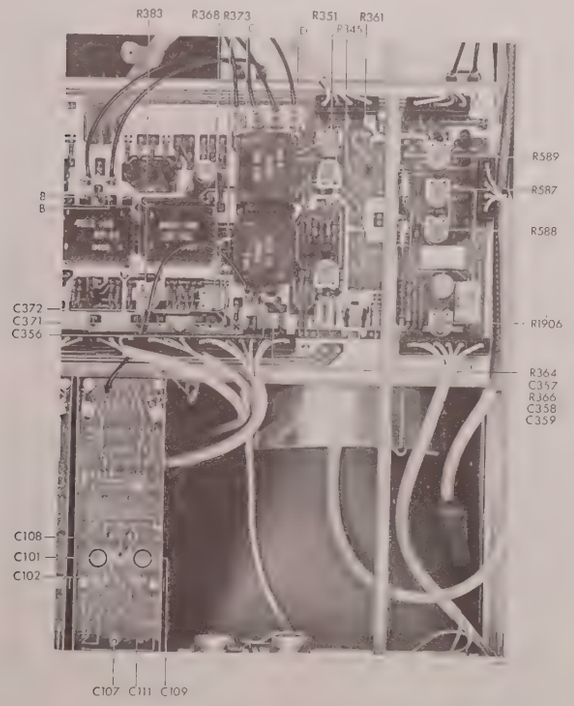


Fig. 3.15. Intermediate amplifier board with adjusting references

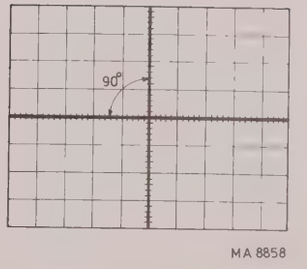


Fig. 3.16. Orthogonality check

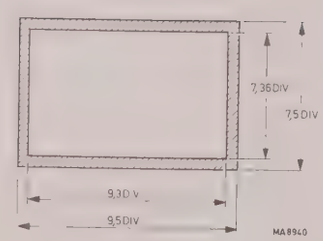


Fig. 3.17. Geometry check

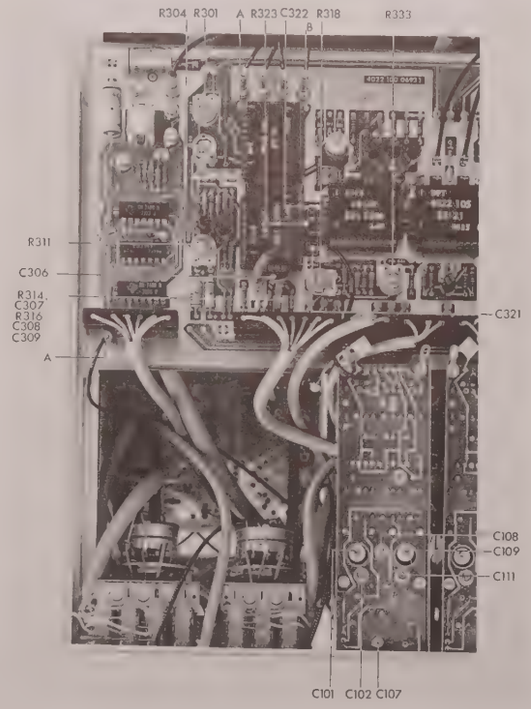


Fig. 3.18. Intermediate amplifier board with adjusting references

Fig. 3.19. Final Y amplifier with adjusting references

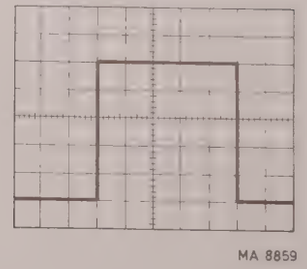


Fig. 3.20. Pulse response

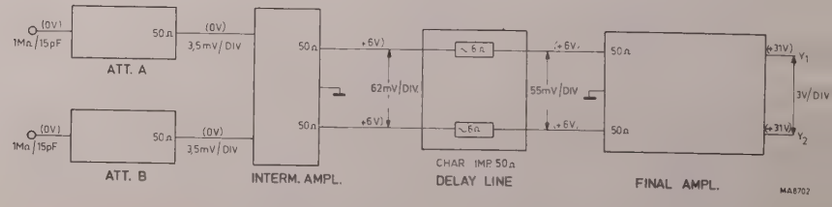


Fig. 3.21. Y Amplifier voltage levels

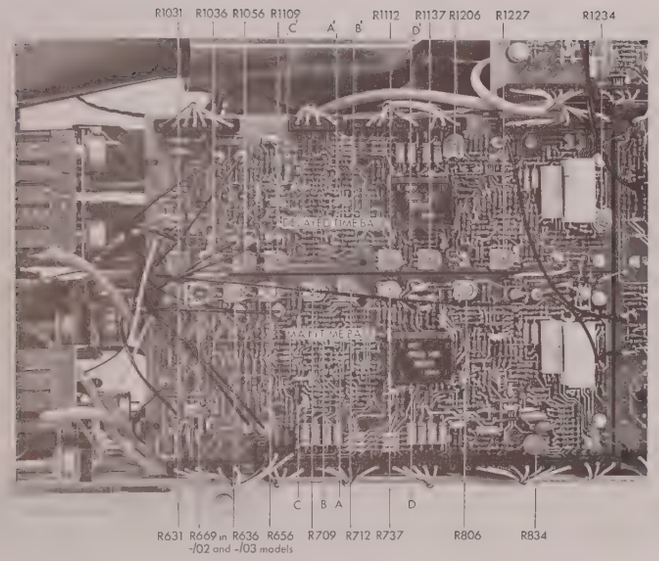


Fig. 3.22. Time-base boards with adjusting references

Fig. 3.23. Effect of LF trigger coupling control

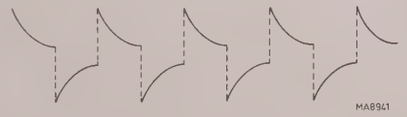


Fig. 3.24. Effect of HF trigger coupling control

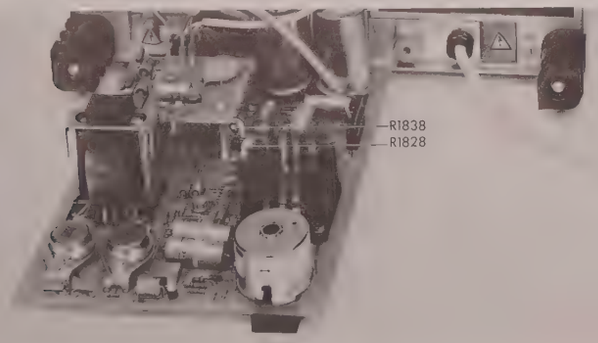


Fig. 3.25. Power supply with adjusting references

3.5. TEST AND REPAIR HINTS

3.5.1. General information

- Use an isolating transformer when measurements must be made in the power supply
- For measuring on the printed-wiring boards, test-pins with sharp points must be used. Be careful not to cause a short-circuit by letting the test-pin slip from the test point.
- Use an appropriate soldering iron and solder with a low melting point, if micro-miniature semi-conductors must be replaced (for recommended iron and solder, refer to section 3.3.15.1.). It is essential to earth the tip of the soldering iron to the mass of the oscilloscope.
- Be very careful not to bend the pins on the neck of the c.r.t., since this is likely to result in a gas-leak
- Do not remove or insert hybrid circuits when the instrument is switched in
- Do not plug and unplug connectors when the instrument is switched in
- Do not touch any trim potentiometers or trimmers before a fault has been located

3.5.2. Y Channels

3.5.2.1. General

If there is a fault in one of the Y channels, it can easily be traced to a certain unit by combining the attenuator of one channel and the intermediate amplifier part of the other channel.
This is simply a matter of plugging coaxial cables. For bias and signal levels, refer to Fig. 3.21.

3.5.2.2. Attenuator

Be careful if a reed relay must be replaced. Such a relay consists of a glass tube, containing the contact points, and a coil. The coil is fitted around the glass tube, with a piece of foil in between for shielding. Since the glass tube is rather fragile, the connection wire of the relay must be bent and soldered with caution. Do not twist the connection wires, as this may cause broken glass-metal seal and unreliable contact inside the glass-tube.

3.5.2.3. Intermediate amplifier

- When you are measuring in the intermediate amplifier, do not remove circuit blocks IC301 and IC351. Blocks IC302 and IC352 supply current to these blocks and the measuring results are not reliable any longer when the load of IC302 and IC352 has been removed.
- If the AMPL vernier control does not work, first check IC353 (for channel A) or IC303 (for channel B).
- If the chopper square-wave is asymmetrical, which shows on the screen as a difference in brilliance of the two traces in the CHOP mode, check circuit block IC306.
- If the common-mode rejection factor is too low, check IC304 and IC354. If necessary, fit a capacitor of 0,8 pF ... 2,2 pF between the soldering tags near the coaxial cable of input A or B on the intermediate amplifier board.

3.5.2.4. Final amplifier

- The coaxial cables between IC401 and the delay line may be unplugged for measurements.
- The final amplifier unit is unaccessible for measurements when it is still inside the oscilloscope. It is, however, possible to take the unit out of the oscilloscope (refer to section 3.3.6.) and operate it there.
  The multipole connector and the 50-Ohm-cables from the delay line must remain connected. The connections to the c.r.t. are too short, but it is possible to bypass the c.r.t. filter and leave it out of the circuit. The bypass can be made by interconnecting the lead from the collector of TS401 and the lead to R420 on the amplifier board, and the lead from TS402 and the lead to R431. In this way, there is a current path and a test oscilloscope may be connected across R420 ... R431. Only l.f. and d.c. measurements are possible, of course, with this method.
- If pulse-top errors arise spontaneously, check the c.r.t. filter for interruptions and contact failure.
  Check also the c.r.t. pins on corrosion.

3.5.3. Triggering

- The input stage can be normally measured on the base of the transistors. On the collectors, however, the signal is current. On the collectors of TS603 and TS618 the signal is voltage again. We refer all the time to components of the main time-base, but the same details apply to the delayed time-base.
- The emitter of TS634 is connected to test point A and the emitter of TS642 to test point B (Fig. 3.22). The signal on these test points in voltage and can be measured with the aid of an oscilloscope.

– Test point C is connected to the base of transistor TS637 (Fig. 3.22). The signal on this point is also voltage.
– Test point D (Fig. 3.22) is connected to point 4 of IC601.
With an input signal of approx. 6 DIV applied to the oscilloscope, a square-wave can be measured on this point.
If this signal is there and the oscilloscope cannot be triggered, the presence of an output signal on point 16 of IC601 must be checked. This signal consists of very narrow negative-going spikes which are best displayed on a sampling oscilloscope. You may also measure the pulses on point 14 of the circuit block. These pulses which are positive-going and control the auto-circuit are not as steep as the ones on point 16 and as such, easier to display.
If there are pulses on point 14, you may almost take it for granted that there are also pulses on point 16.
– If there is no triggering, another fault possibility is stabistor GR606. On point 15 of IC601 is normally a voltage of 9 V, but with a faulty stabistor this voltage will be approx. 15 V.

3.5.4. Time-base generator

– The easiest way to test the time-base generator (we refer here to the main time-base generator, but a similar procedure applies to the delayed time-base) is to remove transistors TS807 and TS808, switch in a low sweep speed and short-circuit the cathode of GR801 to earth. During the time that this short-circuit exists, C807 is charged. The charging process can be traced through the time-base generator, where the changing level must be measured in all circuits.
A fault is then located at a point which does not follow the changing level.
– Transistor TS807 can be removed without disturbing the working of the time-base generator.

3.5.5. Final X amplifier

– To check the d.c. balance of this stage, you may remove transistors TS1704 and TS1706. It is not possible to remove transistors furtheron in the circuit for this measurement, since one half of the circuit has been connected to +110 V and the other half to −110 V.
– All signals in the final X amplifier are currents, but voltage can be measured on the X deflection plates. The voltage on each plate must be approx. 32 V. If one of the plate voltages shows a considerable deviation from this value, the corresponding side of the amplifier must be checked. The most likely fault would be a faulty zener diode.

3.5.6. Z Unit

– If the trace brilliance cannot be turned down with the INTENS control, transistor TS509 and diode GR505 must be checked. The cause may be the following.
If the connection wire of C522 is unplugged while the oscilloscope is operating, capacitor C522 is charged. When the cable is plugged in again, transistor TS509 and may-be diode GR505 are likely to be destroyed by the surge. So if you have disconnected the cable of C522 and you want to plug it in again, switch off the oscilloscope, discharge the capacitor, plug in the cable and switch the oscilloscope on again.
Also be very careful if the unplugged capacitor-cable is dangling about in the circuitry, because this too may cause the same damage.
– If the 2-kV-generator breaks down, check transistor TS2004.

3.6. MAINTENANCE

After removal (see section 3.3.2.) the cabinet plates may be cleaned with a mild non-abrasive household detergent. Do not use chemical solutions such as trichlorethylene and acetone.

The text plate may be cleaned with the same detergent, with alcohol or with white spirit. Always use a soft cloth or cotton wool.

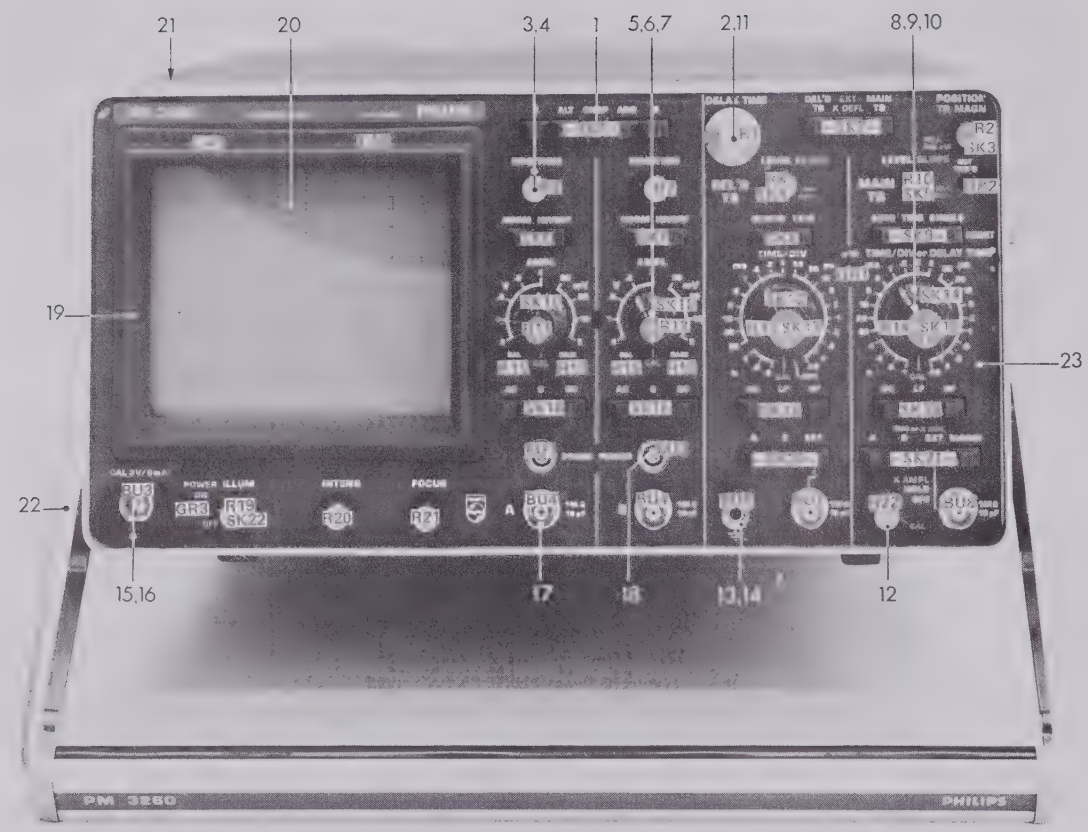


Fig. 3.26. Front view with item numbers and circuit symbols

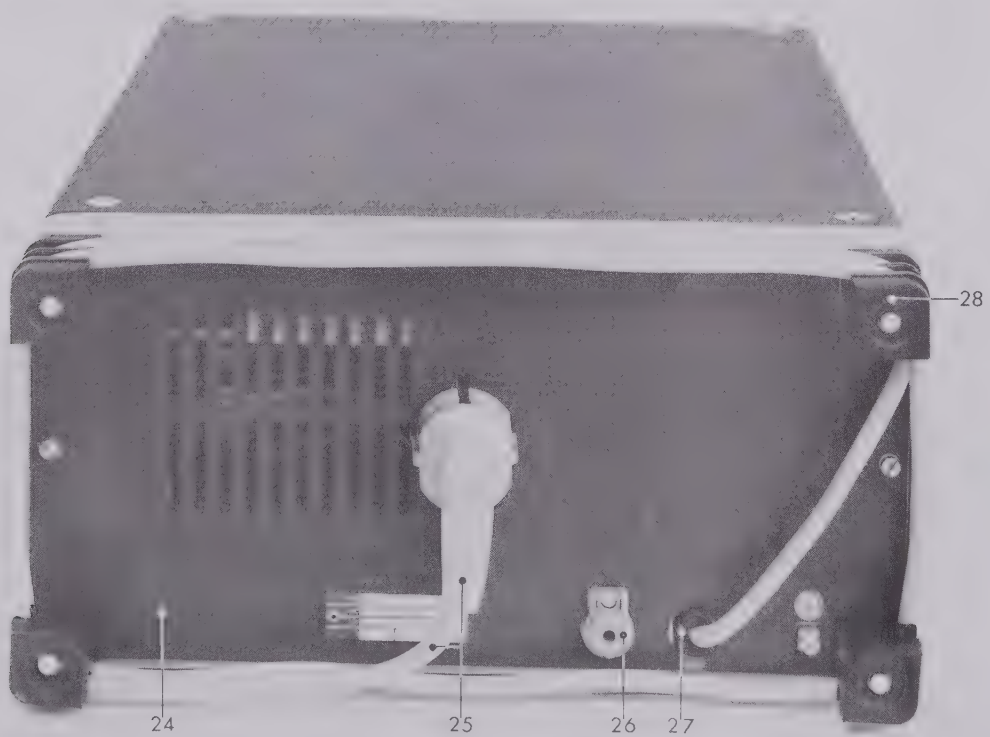


Fig. 3.27. Rear view with item numbers

3.7. PARTS LISTS AND DIAGRAMS

(Subject to alteration without notice)

3.7.1. Mechanical parts

Item	*Order number*	*Description*
Front (Fig. 3.26)		
1	5322 414 14011	Knob for push-button switches
2	5322 414 34147	Knob with ten-turn dial
3	5322 414 34134	Knob, dia 10 mm
	5322 492 64337	Retaining spring for item 3
4	5322 414 74015	Cover, grey with dash, for item 3
5	5322 414 34079	Knob, dia 18,7 mm, shaft dia 6 mm
6	5322 414 34091	Knob, dia 10 mm, shaft dia 4 mm
7	5322 414 74029	Cover, blue with dash, for item 6
8	5322 414 34081	Knob, dia 24 mm, shaft dia 6 mm
9	5322 414 34119	Knob, dia 14 mm, shaft dia 4 mm
10	5322 414 74016	Cover, blue with dash, for item 9
11	5322 414 34133	Knob, dia 10 mm, shaft dia 1/8" for PM 3260E
	5322 414 74031	Cover, grey, for item 11
12	5322 414 74028	Skirt for knob
13	5322 535 80523	Earth socket
14	5322 505 14178	Serrated nut for item 13
15	5322 267 14014	CAL socket
	5322 505 14184	Plastic nut for item 15
	5322 263 54003	BNC Adapter for item 15
16	5322 405 94073	Current loop
17	5322 267 10004	BNC socket
18	5322 265 30096	Probe-power socket
19	5322 451 34004	Bezel
20	5322 480 34046	Contrast filter, grey
20	5322 480 34047	Contrast filter, blue
21	5322 417 24024	Quick fastener, complete
22	5322 498 54044	Bracket, left-hand side
22	5322 498 54043	Bracket, right-hand side
22	5322 498 54045	Grip
22	5322 535 74401	Locking pin
22	5322 492 54155	Spring
22	5322 498 54042	Plastic protection strip for grip
23	5322 455 84034	Text plate PM 3260E
23	5322 455 84043	Text plate PM 3260 standard model
	5322 447 94169	Front cover, complete
	5322 447 94147	Upper cabinet plate, complete
	5322 447 94146	Lower cabinet plate, complete
	5322 462 44155	Rubber foot
Rear (Fig. 3.27)		
24	5322 447 94148	Rear cabinet plate
25	5322 321 14001	Mains cable
26	5322 256 34019	Fuse holder
27	5322 325 60119	Cable cleat
28	5322 462 44154	Nylon foot, complete

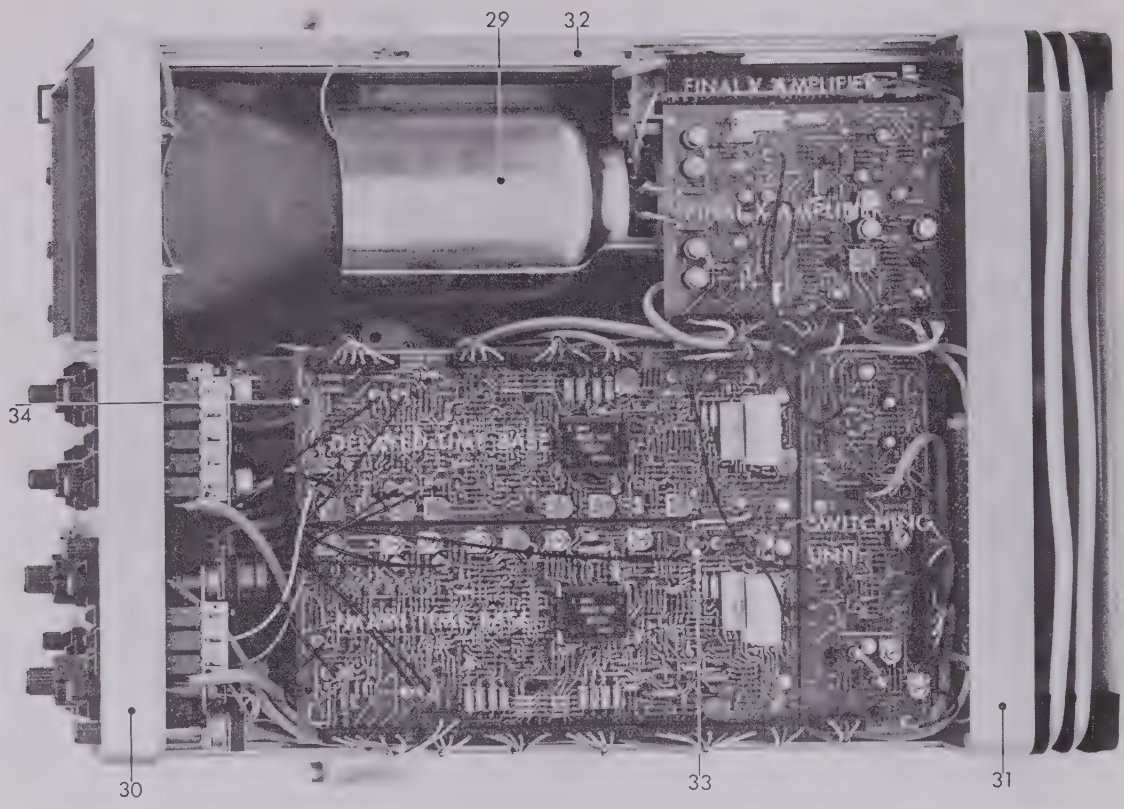


Fig. 3.28. Top view with item numbers

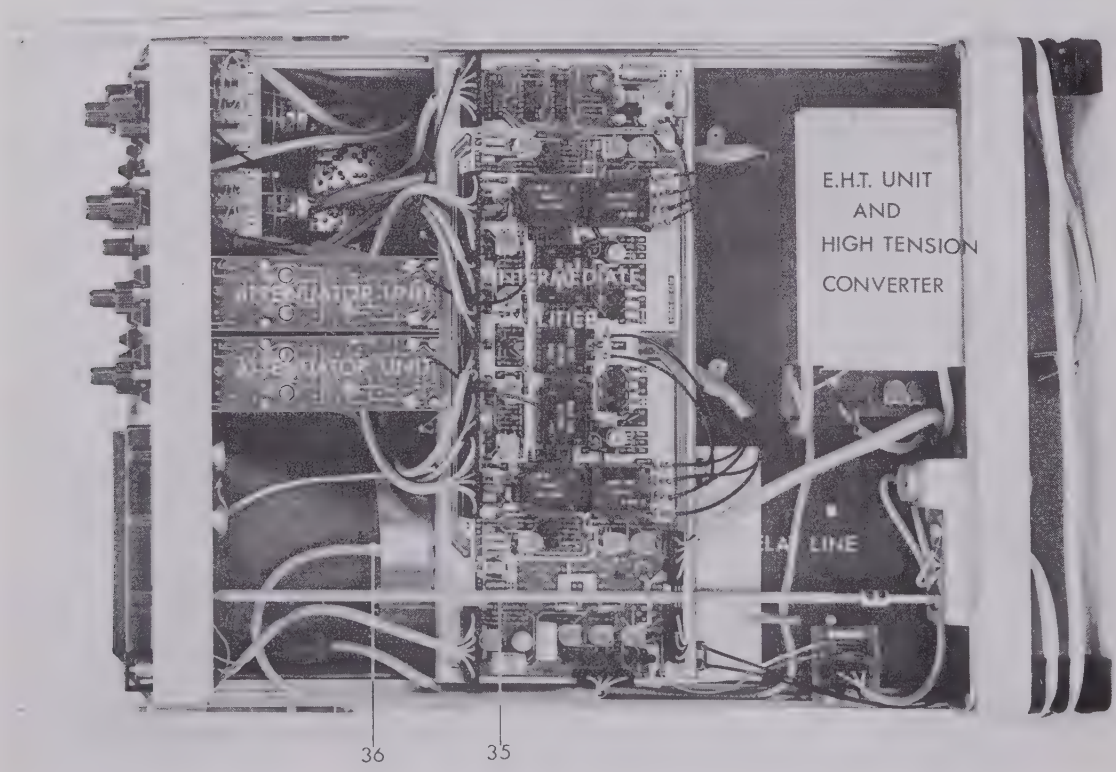


Fig. 3.29. Bottom view with item numbers

Item	*Order number*	*Description*	
Top (Fig. 3.28)			
29	5322 462 54085	Mu-metal c.r.t. screening	
30	5322 447 94143	Cast-aluminium front plate	
31	5322 447 94144	Cast-aluminium rear plate	
32	5322 447 94145	Aluminium side strip	
32	4822 502 30047	Screw to fit item 32 to items 30 and 31	
32	5322 532 14174	Earthing ring	
33	5322 320 10064	Coaxial cable (50 cm) with plug, 50 Ohms	
34	5322 462 34121	Circuit-board support	
Bottom (Fig. 3.29)			
35	5322 535 94656	Plastic spindle	
36	5322 150 14013	Correction coil	
Miscellaneous			
37	5322 505 14185	Special nut for attenuator switch	
38	5322 395 54023	Tool for item 37	
39	5322 505 14186	Special nut for potentiometer unit	
40	5322 395 54024	Tool for item 39	
41	5322 255 44088	Holder for LED	
42	5322 462 44153	Clamping buffer for c.r.t. front	
43	5322 532 74014	Sleeve for c.r.t. neck	
44	5322 405 94074	Male clamping piece for push-button sets	
45	5322 405 94075	Female clamping piece for push-button sets	
46	5322 502 11142	Screw M3x20 for items 44 and 45	
47	5322 532 14526	Filler ring for ten-turn potentiometer in PM 3260E	
48	5322 492 64394	Earthing leaf spring	
49	5322 255 44026	10-Way terminal strip	
50	4822 253 30025	Fuse, 2 A, slow-blow	
51	5322 276 14158	Single push-button unit for the various sets	
52	5322 267 34043	Coax. socket, vertically mounted on p.w. boards	
53	5322 267 34042	Coax. socket, mounted slanting on final Y ampl. board	
54	4822 505 10029	Square nut M3 in aluminium side strip of cabinet	
Coaxial cables with connectors at both ends			
55	5322 320 14031	440-mm-cable between the trigger outputs of the intermediate amplifier and the trigger inputs of the time-base circuits	
56	5322 320 14029	400-mm-cable between the ALT output of the m.t.b. and switching logic on intermediate ampl. board. Also between chopper-blanking output on intermediate ampl. board and Z amplifier.	
57	5322 320 14028	300-mm-cable between delay-line output and final Y amplifier.	
58	5322 320 14027	500-mm-cable between X output of m.t.b. and X amplifier on switching unit	
Multi pole plugs and sockets			
59	4822 266 30071	3-pole plug	(Stocko MKF 803-1-0-303)
60	4822 265 30121	3-pole socket	(Stocko MKS 823-1-0-303)
61	4822 266 30072	4-pole plug	(Stocko MKF 804-1-0-404)
62	4822 265 30119	4-pole socket	(Stocko MKS 824-1-0-404)
63	4822 266 30073	6-pole plug	(Stocko MKF 806-1-0-606)
64	4822 265 30117	6-pole socket	(Stocko MKS 826-1-0-606)
65	4822 266 40057	7-pole plug	(Stocko MKF 807-1-0-707)
66	4822 265 40119	7-pole socket	(Stocko MKS 827-1-0-707)

UNITS

Ordering code	*Fig.*	*Description*
5322 218 64052	3.29	Attenuator complete PM 3260E
5322 218 64044	3.29	Attenuator complete PM 3260 standard model
5322 216 54101	3.29	Intermediate amplifier [1]
5322 320 44014	3.29	Delay line (L301)
5322 216 54102	3.28	Final Y-amplifier
5322 216 54096	3.28	Main time-base
5322 216 54097	3.28	Delayed time-base
5322 216 54098	3.28	Switching unit [2]
5322 216 54099	3.28	Final X and unblanking amplifier
5322 216 54094		2 kV converter [3]
5322 218 64046	3.29	EHT unit
4822 390 20023		Grease for EHT connector (Dow Corning "4 Compound" Silicon Dielectric; MIL.S. 8660B)
5322 216 54095		Focusing unit
5322 216 54093	3.30	Power supply unit
5322 218 64045	3.30	Mains filter

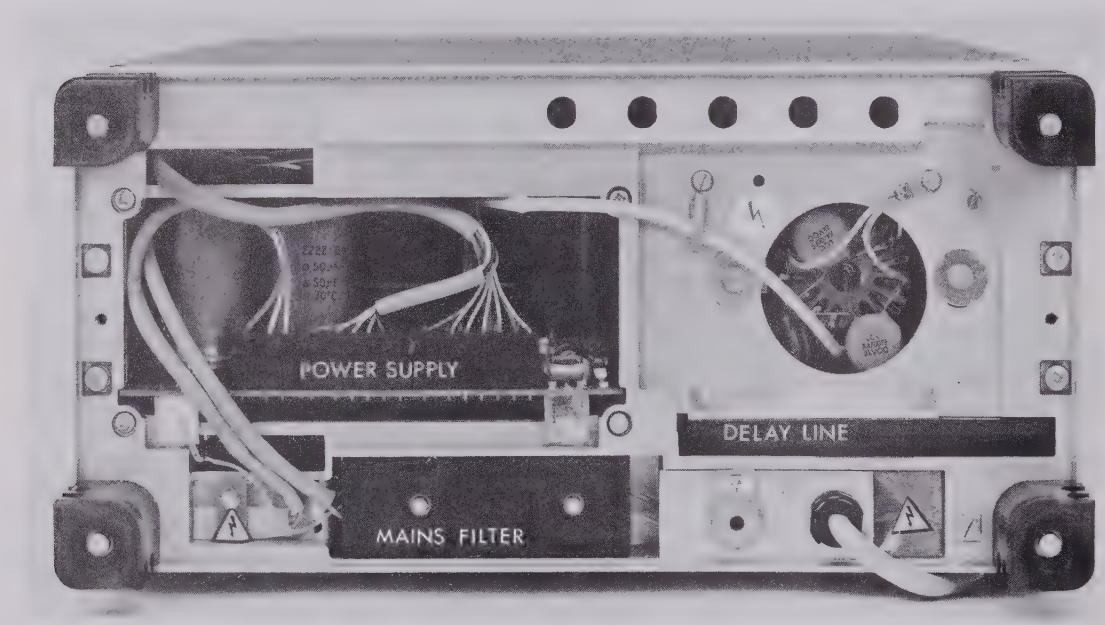


Fig. 3.30. Rear view without rear plate

The units listed above are those of the PM 3260/03 model and can be used for the PM 3260/01 and —/02 models.

1) This unit contains a probe power circuit and a graticule illumination circuit (for two 12 V - pilot lamps in series).

2) If this unit is mounted in the PM 3260/01 or —/02, the mounting studs on the power supply screening box must be repositioned.

3) If this unit is used in a PM 3260/01 model, the 4-pole connector to the c.r.t. base must be replaced by a 3-pole version (order no. 4822 266 30071).

3.7.2. Electrical parts

Itemnos. (e.g. C--, R--, TS--) have been divided in groups which relate to the circuit unit, according to following table.

1 --- 99	front (or rear) panel of the instrument	
100 --- 199	Y input attenuator	
300 --- 399	Intermediate Y amplifier	
400 --- 499	Final Y amplifier	
500 --- 599	Z amplifier	
600 --- 799	Trigg.	Main time-base generator
800 --- 904	Sweep circuit	
920 --- 999	Switch	
1000 --- 1199	Trigg.	Delayed time-base generator
1200 --- 1299	Sweep circuit	
1300 --- 1399	Switch	
1400 --- 1599	X Defl. selector	
1600 --- 1699	Logic and probe power (interm. Y ampl. p.c.b.)	
1700 --- 1799	Final X amplifier	
1800 --- 1899	Power supply	
1900 --- 1999	Calibration generator	
2000 --- 2099	2 kV converter	

ITEM	ORDERING NUMBER	FARAD	TOL (%)	VOLTS	REMARKS
CAPACITORS					
C101	5322 125 64009	3P		500	TRIMMER
C102	5322 125 60068	4,5P		500	TRIMMER
C103	5322 123 34001	30	10	500	MICA
C104	5322 122 30043	10N	+20+100	40	CERAMIC PLATE
C104	4822 121 40171	22N	10	400	POLYESTER FOIL
C105	4822 121 40171	22N	10	400	POLYESTER FOIL
C106	4822 122 31203	39	2	500	CERAMIC PLATE
C107	5322 125 64009	1,5P		500	TRIMMER
C108	5322 125 64014	3P		500	TRIMMER
C109	5322 125 64009	3P		500	TRIMMER
C111	5322 125 60068	4,5P		500	TRIMMER
C112	5322 123 10168	300	10	500	MICA
C113,116	4822 122 30103	22N	+10+100	40	CERAMIC PLATE
C301,304	5322 122 30043	10N	+20+100	40	CERAMIC PLATE
ADJUST ON TEST	C306,309				
C311,318	5322 122 30043	10N	+20+100	40	CERAMIC PLATE
ADJUST ON TEST	C319,322				
C323,331	5322 122 30043	10N	+20+100	40	CERAMIC PLATE
C332,333	4822 124 20452	33MUF		6,3	ELECTROLYTIC
C335,341	5322 122 30043	10N	+20+100	40	CERAMIC PLATE
C351,354	5322 122 30043	10N	+20+100	40	CERAMIC PLATE
ADJUST ON TEST	C356,359				
C361,368	5322 122 30043	10N	+20+100	40	CERAMIC PLATE
ADJUST ON TEST	C369,372				
C373,381	5322 122 30043	10N	+20+100	40	CERAMIC PLATE
C382,384	4822 124 20452	33MUF		6,3	ELECTROLYTIC
C385,386	5322 122 30043	10N	+20+100	40	CERAMIC PLATE
ADJUST ON TEST	C400				
C401	4822 122 30129	4,7N	10	100	CERAMIC PLATE
ADJUST ON TEST	C402,404				
C406	4822 121 41147	33N	10	250	POLYESTER FOIL
C407	5322 125 50051	18		300	TRIMMER
C408	4822 122 30129	4,7N	10	100	CERAMIC PLATE
C409	4822 122 31085	150	2	100	CERAMIC PLATE
C410	4822 122 31038	2,7P	0,25P	100	CERAMIC PLATE
C411	4822 122 30129	4,7N	10	100	CERAMIC PLATE
C412	4822 122 31085	150	2	100	CERAMIC PLATE
C413,414	5322 121 44138	47N	10	250	POLYESTER FOIL
C416	4822 122 30129	4,7N	10	100	CERAMIC PLATE
C417	4822 122 31085	150	2	100	CERAMIC PLATE
C419,421	4822 122 30128	4,7N	10	100	CERAMIC PLATE
C500	4822 122 30043	10N	+20+100	40	CERAMIC PLATE
C501	4822 122 30103	22N	+20+100	40	CERAMIC PLATE
C502	4822 122 30128	4,7N	10	100	CERAMIC PLATE
C503	4822 122 31116	2,2N	10	500	CERAMIC PLATE
C504,505	4822 121 41161	100N	10	250	POLYESTER FOIL
C506	4822 122 30043	10N	+20+100	40	CERAMIC PLATE
C507	4822 122 30034	15	2	100	CERAMIC PLATE
C508	4822 121 41161	100N	10	250	POLYESTER FOIL
C509	5322 125 50048	3,5P		300	TRIMMER
C510	4822 122 31197	15P	2	500	CERAMIC PLATE
C511	4822 122 30128	4,7N	10	100	CERAMIC PLATE
TRACE ONPRINT	C512				
C513	4822 122 30043	10N	+20+100	40	CERAMIC PLATE
C514	5322 122 30098	3,9N	10	100	CERAMIC PLATE
C515,516	4822 122 30043	10N	+20+100	40	CERAMIC PLATE
C517	5322 122 30098	3,9N	10	100	CERAMIC PLATE
C518 519	4822 122 30043	10N	10	100	CERAMIC PLATE
C520	4822 122 31197	15P	2	500	CERAMIC PLATE
C521	5322 122 50044	1N	+20+50	3KV	CERAMIC DISK
C522	5322 122 50001	4,7N	+20+50	3KV	CERAMIC DISK
C523	4822 121 41152	47N	10	250	POLYESTER FOIL
C523	4822 121 41147	33N	10	250	POLYESTER FOIL
C524	4822 122 31211	100	10	500	CERAMIC PLATE
C526,527	4822 121 41161	100N	10	250	POLYESTER FOIL
C528	4822 121 40123	15N	10	1000	POLYESTER FOIL
C529	4822 121 40195	33N	10	1600	POLYESTER FOIL
C530	5322 122 50001	4,7N	+20+50	3KV	CERAMIC DISK

ITEM	ORDERING NUMBER	FARAD	TOL	VOLTS	REMARKS
C531	4822 121 40429	220N	10	630	POLYESTER FOIL
C532,533	4822 122 31174	2,7N	10	500	CERAMIC PLATE
C534	5322 122 50044	1N	+20-50	3Kv	CERAMIC DISK
C536	4822 122 31174	2,7N	10	500	CERAMIC PLATE
C537	4822 121 41152	47N	10	250	POLYESTER FOIL
C537	4822 121 41147	33N	10	250	POLYESTER FOIL
C538	5322 122 30103	22N	+20-100	40	CERAMIC PLATE
C538	4822 121 41147	33N	10	250	POLYESTER FOIL
C539	5322 121 54054	22N	+20-80	63	POLYSTYRENE FOIL
C541,543	4822 122 30043	10N	+20-100	40	CERAMIC PLATE
C601	4822 122 31198	18	2	500	CERAMIC PLATE
C601	4822 120 11049	6,8P	0,5P	500	CERAMIC
C602	4822 122 31205	47	2	500	CERAMIC PLATE
C602	4822 120 11052	8,2P	0,5P	500	CERAMIC
C607	4822 122 30091	390	2	100	CERAMIC PLATE
C608	5322 122 30103	22N	+20-100	40	CERAMIC PLATE
C610	4822 122 30128	4,7N	10	100	CERAMIC PLATE
C611	4822 122 30045	27	2	100	CERAMIC PLATE
C612 616	5322 122 30103	22N	+20-100	40	CERAMIC PLATE
C617	4822 122 30045	27	2	100	CERAMIC PLATE
C618,619	4822 122 31054	10	2	100	CERAMIC PLATE
C620	4822 122 30043	10N	+20-100	40	CERAMIC PLATE
C621 623	5322 122 30103	22N	+20-100	40	CERAMIC PLATE
C624,631	5322 122 30103	22N	+20-100	40	CERAMIC PLATE
C634,642	5322 122 30103	22N	+20-100	40	CERAMIC PLATE
C643	5322 124 10014	4,7MF		35	ELECTROLYTIC TANTALUM
C644,647	4822 124 20475	10MUF		25	ELECTROLYTIC
C646,648	4822 124 20459	22MUF		10	ELECTROLYTIC
C800	4822 124 20459	22MUF		10	ELECTROLYTIC
C801	4822 122 31061	18	2	100	CERAMIC PLATE
C801	4822 122 31058	15P	2	100	CERAMIC PLATE
C802	5322 122 30103	22N	+20-100	40	CERAMIC PLATE
C803	4822 122 30045	27	2	100	CERAMIC PLATE
C804	5322 122 30103	22N	+20-100	40	CERAMIC PLATE
C805	5322 121 54062	4,3N	1	63	POLYSTYRENE FOIL
C806	5322 121 54076	453	1	250	POLYSTYRENE FOIL
C807	5322 121 40224	4,7MUF	10	100	POLYESTER FOIL
C808	5322 121 50375	47N	1	63	POLYSTYRENE FOIL
C809	5322 124 14068	100MF		10	ELECTROLYTIC TANTALUM
C809	5322 124 14057	100MUF		10	ELECTROLYTIC TANTALUM
C810	5322 122 30103	22N	+20-100	40	CERAMIC PLATE
C811	4822 121 40079	220N	10	100	POLYESTER FOIL
C812	4822 122 30128	4,7N	2	100	CERAMIC PLATE
C813,818	5322 122 30103	22N	+20-100	40	CERAMIC PLATE
SELECT ON TEST	C816				
C816	4822 122 31221	1,5N	2	100	CERAMIC PLATE
C820,823	4822 124 20459	22MUF		10	ELECTROLYTIC
C824	5322 122 30103	22N	+20-100	40	CERAMIC PLATE
C825	4822 122 31219	150P	10	500	CERAMIC PLATE
C826	5322 122 30103	22N	+20-100	40	CERAMIC PLATE
C1001	4822 122 31198	18	2	500	CERAMIC PLATE
C1001	4822 120 11049	6,8P	0,5P	500	CERAMIC
C1002	4822 122 31205	47	2	500	CERAMIC PLATE
C1002	4822 120 11052	8,2P	0,5P	500	CERAMIC
C1007	4822 122 30091	390	2	100	CERAMIC PLATE
C1008	5322 122 30103	22	+20-100	40	CERAMIC PLATE
C1010	4822 122 30128	4,7N	10	100	CERAMIC PLATE
C1011	4822 122 30045	27	2	100	CERAMIC PLATE
C1013,14	5322 122 30103	22	+20-100	40	CERAMIC PLATE
C1017	4822 122 30045	27	2	100	CERAMIC PLATE
C1018,19	4822 122 31054	10	2	100	CERAMIC PLATE
C1021	5322 122 30103	22	+20-100	40	CERAMIC PLATE
C1022,23	5322 122 30103	22N	+20-100	40	CERAMIC PLATE
C1024,31	5322 122 30103	10N	+20-100	40	CERAMIC PLATE
SELECT ON TEST	C1032,33				
C1034,40	5322 122 30103	22K	+20-100	40	CERAMIC PLATE
C1044,47	4822 124 20475	10MUF		25	ELECTROLYTIC
C1046,48	4822 124 20459	22MUF		10	ELECTROLYTIC
C1200	5322 121 54062	4,3N	1	63	POLYSTYRENE FOIL
C1201	4822 122 31061	18	1	100	CERAMIC PLATE

ITEM	ORDERING NUMBER	FARAD	TOL (%)	VOLTS	REMARKS
C1201	4822 122 31058	15P	2	100	CERAMIC PLATE
C1202	5322 121 54076	453	1	250	POLYSTYRENE FOIL
C1203	5322 121 40224	4,7MUF	10	100	POLYESTER FOIL
C1204	5322 121 50375	47N	1	63	POLYSTYRENE FOIL
C1205,07	5322 122 30103	22K	-20+100	40	CERAMIC PLATE
C1208	4822 122 31221	1,5N	2	100	CERAMIC PLATE
C1209	4822 122 31063	22	2	100	CERAMIC PLATE
C1210	5322 122 30103	22K	-20+100	40	CERAMIC PLATE
C1211	4822 122 30045	27	2	100	CERAMIC PLATE
C1212,14	4822 124 20475	10MUF		25	ELECTROLYTIC
C1213,16	4822 124 20459	22MUF		10	ELECTROLYTIC
C1217	4822 122 30103	10N	-20+100	40	CERAMIC PLATE
SELECT ON TEST	C1405,08				
C1406,24	4822 122 30043	10N	-20+100	40	CERAMIC PLATE
C1602	4822 122 31178	680	10	100	CERAMIC PLATE
C1602	4822 122 30031	820P	10	100	CERAMIC PLATE
C1603	4822 122 31085	150	2	100	CERAMIC PLATE
C1604	4822 122 30043	10N	-20+100	40	CERAMIC PLATE
C1605	4822 122 31081	100P	2	100	CERAMIC PLATE
C1606,07	4822 124 20589	220MUF		10	ELECTROLYTIC
C1608	5322 122 30027	1N	10	100	CERAMIC PLATE
C1621,26	5322 122 30043	10N	-20+100	40	CERAMIC PLATE
C1701	4822 122 31116	2,2N	10	500	CERAMIC PLATE
C1702	4822 122 31214	0,82P	0,25P	100	CERAMIC PLATE
C1702	5322 122 34039	0,56P	0,25P	100	CERAMIC PLATE
C1703	5322 125 50048	3,5P		300	TRIMMER
C1704	5322 122 30103	22N	-20+100	40	CERAMIC PLATE
C1706	4822 121 41161	100N	10	250	POLYESTER FOIL
C1707	5322 125 50048	3,5P		300	TRIMMER
C1708	4822 122 31214	0,82P	0,25P	100	CERAMIC PLATE
C1708	5322 122 34039	0,56P	0,25P	100	CERAMIC PLATE
C1709	4822 122 31116	2,2N	10	500	CERAMIC PLATE
C1711	5322 122 30103	22N	-20+100	40	CERAMIC PLATE
C1712	4822 121 41161	100N	10	250	POLYESTER FOIL
C1713	5322 122 30103	22N	-20+100	40	CERAMIC PLATE
C1714	4822 121 41152	47N	10	250	POLYESTER FOIL
C1716	5322 122 30103	22N	-20+100	40	CERAMIC PLATE
C1717	4822 121 41152	47N	10	250	POLYESTER FOIL
C1801	5322 121 44142	220N	10	250	POLYESTER FOIL
C1802,03	5322 122 44009	2,2N	20	250	CERAMIC DISK
C1804	5322 121 44142	220N	10	250	POLYESTER FOIL
C1805	4822 124 20324	4MUF		400	ELECTROLYTIC
C1806,07	4822 124 40066	50+50MU		400	ELECTROLYTIC
C1808,09	5322 124 24123	100MUF		63	ELECTROLYTIC
C1811	4822 121 41143	22N	10	250	POLYESTER FOIL
C1812	4822 124 20581	220MUF		4	ELECTROLYTIC
C1813	4822 121 41143	22N	10	250	POLYESTER FOIL
C1814	4822 124 20459	22MUF		10	ELECTROLYTIC
C1814	4822 124 20467	15MUF		16	ELECTROLYTIC
C1815	4822 122 31173	220P	10	100	CERAMIC PLATE
C1816	4822 121 41161	100N	10	250	POLYESTER FOIL
C1817	4822 124 20583	1MUF		63	ELECTROLYTIC
C1818	4822 124 20461	47MUF		10	ELECTROLYTIC
C1819	4822 124 20459	22MUF		10	ELECTROLYTIC
C1820	4822 122 31175	1N	10	100	CERAMIC PLATE
C1821	4822 124 20501	47MUF		63	ELECTROLYTIC
C1822	4822 124 20475	10MUF		25	ELECTROLYTIC
C1823	4822 121 41161	100N	10	250	POLYESTER FOIL
C1824	4822 124 20465	330		10	ELECTROLYTIC
C1825	5322 122 30134	10N	-20+50	3KV	CERAMIC PLATE
C1826,29	4822 121 41161	100N	10	250	POLYESTER FOIL
C1831,32	4822 124 20497	15MUF		63	ELECTROLYTIC
C1833,37	4822 124 20485	33MUF		40	ELECTROLYTIC
C1838,42	4822 124 20473	68MUF		16	ELECTROLYTIC
C1843,52	4822 124 20454	150MUF		6,3	ELECTROLYTIC
C1901	4822 124 20468	33MUF		16	ELECTROLYTIC
C1902	5322 121 40233	680N	10	100	POLYESTER FOIL
C1903	4822 121 50345	20N	1	63	POLYSTYRENE FOIL
C1904	4822 124 20453	68MUF		6,3	ELECTROLYTIC
C2001	4822 124 20501	47MUF		63	ELECTROLYTIC

ITEM	ORDERING NUMBER	FARAD	TOL (%)	VOLTS	REMARKS
C2002	5322 122 50003	2,7N	+20-50	3KV	CERAMIC DISK
C2002	5322 122 54006	3,3N	+20-50	3KV	CERAMIC DISK
C2003	4822 121 41169	15MUF		16	POLYESTER FOIL
C2004	4822 121 41147	33N	10	250	POLYESTER FOIL
C2005	4822 124 20467	15MUF		16	ELECTROLYTIC
C2007	4822 121 40079	220N	10	100	POLYESTER FOIL
SELECT ON TEST	C2008				
C2018,28	4822 122 20017	220	20	5KV	CERAMIC TUBULAR

ITEM	ORDERING NUMBER	OHM	TOL (%)	TYPE	REMARKS
RESISTORS					
R1	5322 103 64016	5K	TENTURN	1	WIRE-WOUND POTENTIOMETER
R2	5322 101 44015	50K	20	CP20	CARBON POTM LIN + SWITCH
R3	5322 101 24056	1K	20	CP16	CARBON POTM LIN
R7	5322 101 24056	1K	20	CP16	CARBON POTM LIN
R8,10	5322 101 44014	100K	20	CP16	CARBON POTM LIN + SWITCH
R11,12	5322 101 24047	22K	20	CP16	CARBON POTM LIN
R13,14	5322 101 40041	4,7K	20	CP23	CARBON POTM LIN + SWITCH
R15	5322 101 24046	100K	20	CP16	CARBON POTM LIN
R16	4822 101 20416	4,7K	20	CP16	CARBON POTM LIN
R17	5322 101 24046	100	20	CP16	CARBON POTM LIN
R18	4822 101 20416	4,7K	20	CP16	CARBON POTM LIN
R19	5322 101 24055	25K	20	CP16	CARBON POTM LIN
R20,21	4822 101 20417	22K	20	CP16	CARBON POTM LIN
R22	5322 101 24054	10K	20	CP16	CARBON POTM LIN
R101	4822 111 30069	39	5	CR16	CARBON
R101	5322 111 30074	56	5	CR16	CARBON
R102	5322 116 54324	920K	1	MR30	METAL FILM
R103	5322 111 30074	56	5	CR16	CARBON
R103	4822 111 30069	39	5	CR16	CARBON
R104	5322 116 50821	88,9K	1	MR25	METAL FILM
R106	4822 111 30176	18	5	CR16	CARBON
R106	5322 111 30074	56	5	CR16	CARBON
R107	5322 116 54726	200K	1	MR25	METAL FILM
R108	4822 111 30067	33	5	CR16	CARBON
R108	5322 116 54323	800K	1	MR30	METAL FILM
R109	4822 111 30309	560	5	CR16	CARBON
R111	4822 111 30309	560	5	CR16	CARBON
R112	5322 116 54323	800K	1	MR30	METAL FILM
R112	5322 111 30074	56	5	CR16	CARBON
R113	4822 111 30069	39	5	CR16	CARBON
R113	5322 116 54209	992K	1	MR30	METAL FILM
R114	5322 116 54209	992K	1	MR30	METAL FILM
R114	5322 116 50914	8,08K	1	MR25	METAL FILM
R116	5322 111 30074	56	5	CR16	CARBON
R116	4822 111 30069	39	5	CR16	CARBON
R117	5322 116 50914	8,08K	1	MR25	METAL FILM
R118,19	5322 116 50592	442	1	MR25	METAL FILM
R121	4822 111 30347	10	5	CR16	CARBON
R122	4822 111 30304	150K	5	CR16	CARBON
R123	5322 116 54499	249	1	MR25	METAL FILM
R301	5322 101 14069	22K	20	0,5	CARBON TRIMMING POTM
R302	5322 116 54608	7,5K	1	MR25	METAL FILM
R303	5322 116 50586	1,54K	1	MR25	METAL FILM
R304	5322 101 14047	470	20	0,5	CARBON TRIMMING POTM
R306	5322 116 54571	1,96K	1	MR25	METAL FILM
R307	5322 116 50524	3,01K	1	MR25	METAL FILM
R308	5322 116 54585	3,48K	1	MR25	METAL FILM
R309	5322 116 54532	649	1	MR25	METAL FILM
R311	5322 101 14047	470	20	0,5	CARBON TRIMMING POTM
R312	5322 116 50747	1K	1	MR25	METAL FILM
R313	5322 116 54619	10K	1	MR25	METAL FILM
SELECT ON TEST	R314R316				
R317R319	5322 116 50747	1K	1	MR25	METAL FILM
R318	5322 101 14069	22K	20	0,5	CARBON TRIMMING POTM
R321	5322 116 54585	3,48K	1	MR25	METAL FILM
R322	5322 116 54532	649	1	MR25	METAL FILM

ITEM	ORDERING NUMBER	OHM	TOL (%)	TYPE	REMARKS
SELECT ON TEST	R323				
R324	5322 116 54469	100	1	MR25	METAL FILM
R326	5322 116 54472	105	1	MR25	METAL FILM
R327	5322 116 50414	2,87K	1	MR25	METAL FILM
R328	5322 116 54469	100	1	MR25	METAL FILM
R329	5322 116 50414	2,87K	1	MR25	METAL FILM
R331	5322 116 50669	205	1	MR25	METAL FILM
R332	5322 116 50747	1K	1	MR25	METAL FILM
R333	5322 101 14069	22K	20	0,5	CARBON TRIMMING POTM
R334	5322 116 54585	3,48K	1	MR25	METAL FILM
R336	5322 116 54589	3,83K	1	MR25	METAL FILM
R337	5322 116 50747	1K	1	MR25	METAL FILM
R338R339	5322 116 50509	4,87K	1	MR25	METAL FILM
R341R342	5322 116 50747	1K	1	MR25	METAL FILM
R343R344	5322 116 50491	22,6	1	MR25	METAL FILM
R345	5322 116 54469	100	1	MR25	METAL FILM
R346	5322 116 50459	422	1	MR25	METAL FILM
R347	5322 116 50583	5,9K	1	MR25	METAL FILM
R348	5322 116 54608	7,5K	1	MR25	METAL FILM
R349	5322 116 50728	1,87K	1	MR25	METAL FILM
R351	5322 101 14069	22K	20	0,5	CARBON TRIMMING POTM
R352	5322 116 54608	7,5K	1	MR25	METAL FILM
R353	5322 116 50586	1,54K	1	MR25	METAL FILM
R354	5322 101 14047	470	20	0,5	CARBON TRIMMING POTM
R356	5322 116 54571	1,96	1	MR25	METAL FILM
R357	5322 116 50524	3,01K	1	MR25	METAL FILM
R358	5322 116 54585	3,48K	1	MR25	METAL FILM
R359	5322 116 54532	649	1	MR25	METAL FILM
R361	5322 101 14047	470	20	0,5	CARBON TRIMMING POTM
R362	5322 116 50747	1K	1	MR25	METAL FILM
R363	5322 116 54619	10K	1	MR25	METAL FILM
SELECT ON TEST	R364R366				
R367	5322 116 50747	1K	1	MR25	METAL FILM
R368	5322 101 14069	22K	20	0,5	CARBON TRIMMING POTM
R369	5322 116 50747	1K	1	MR25	METAL FILM
R371	5322 116 54585	3,48K	1	MR25	METAL FILM
R372	5322 116 54532	649	1	MR25	METAL FILM
SELECT ON TEST	R373				
R374	5322 116 54469	100	1	MR25	METAL FILM
R376	5322 116 54472	105	1	MR25	METAL FILM
R377	5322 116 50414	2,87K	1	MR25	METAL FILM
R378	5322 116 54469	100	1	MR25	METAL FILM
R379	5322 116 50414	2,87K	1	MR25	METAL FILM
R381	5322 116 50669	205	1	MR25	METAL FILM
R382	5322 116 50747	1K	1	MR25	METAL FILM
R383	5322 101 14069	22K	20	0,5	CARBON TRIMMING POTM
R384	5322 116 54585	3,48K	1	MR25	METAL FILM
R386	5322 116 54589	3,83K	1	MR25	METAL FILM
R387	5322 116 50747	1K	1	MR25	METAL FILM
R388R389	5322 116 50509	4,87K	1	MR25	METAL FILM
R391R392	5322 116 50747	1K	1	MR25	METAL FILM
R393R394	5322 116 50491	22,6	1	MR25	METAL FILM
R401R402	5322 116 54442	51,1	1	MR25	METAL FILM
SELECT ON TEST	R403,,07				
R408	5322 100 10138	100	20	0,75	CARBON TRIMMING POTM
R409R410	5322 101 14056	47K	20	0,75	CARBON TRIMMING POTM
R411	5322 116 50767	2,15K	1	MR25	METAL FILM
R412R413	5322 116 54696	100K	1	MR25	METAL FILM
R414	5322 116 50767	2,15K	1	MR25	METAL FILM
R417	5322 111 44153	15	5	CR16	CARBON
R418	5322 116 64005	200	5	5	METAL OXIDE
R395	5322 116 54469	100	1	MR25	METAL FILM
R419,421	5322 116 54466	90,9	1	MR25	METAL FILM
R422	5322 116 54534	681	1	MR25	METAL FILM
R422	5322 116 50592	442	1	MR25	METAL FILM
R423	5322 101 14093	50	20	0,5	CARBON TRIMMING POTM
R424R426	5322 116 54466	90,9	1	MR25	METAL FILM
R427	5322 116 64005	200	5	5	METAL OXIDE
R428	5322 111 44153	15	5	CR16	CARBON

ITEM	ORDERING NUMBER	OHM	TOL (%)	TYPE	REMARKS
R429	5322 116 50664	2,05K	1	MR25	METAL FILM
R430	5322 116 54603	6,49K	1	MR25	METAL FILM
R432	5322 100 10141	10K	20	0,75	CARBON TRIMMING POTM
R433	5322 116 50621	536	1	MR25	METAL FILM
R434	5322 116 54536	750	1	MR25	METAL FILM
R436	5322 116 54565	1,62K	1	MR25	METAL FILM
R506R507	5322 116 54442	51,1	1	MR25	METAL FILM
R508	5322 116 54567	1,69K	1	MR25	METAL FILM
R509	5322 116 50557	46,4K	1	MR25	METAL FILM
R511	5322 116 54743	301K	1	MR25	METAL FILM
R512	5322 116 54623	11K	1	MR25	METAL FILM
R513	5322 116 54565	1,62K	1	MR25	METAL FILM
R514R516	5322 116 54005	3,32K	1	MR25	METAL FILM
R517	5322 116 50728	1,87K	1	MR25	METAL FILM
R517	5322 116 50664	2,05K	1	MR25	METAL FILM
R518	5322 116 54661	34,8K	1	MR25	METAL FILM
R519	5322 116 54536	750	1	MR25	METAL FILM
R520	4822 110 63036	2,2	5	CR25	CARBON
R521	5322 116 54689	82,5K	1	MR25	METAL FILM
R522	5322 116 50492	46,4	1	MR25	METAL FILM
R523	5322 116 54462	82,5	1	MR25	METAL FILM
R524	5322 116 54567	1,69K	1	MR25	METAL FILM
R525	5322 116 54538	787	1	MR25	METAL FILM
R526	5322 116 50492	46,4	1	MR25	METAL FILM
R528	5322 116 50492	46,4	1	MR25	METAL FILM
R529	5322 116 50536	464	1	MR25	METAL FILM
R531	5322 116 54617	9,53K	1	MR25	METAL FILM
R532	5322 116 54665	40,2K	1	MR25	METAL FILM
R533	5322 116 54617	9,53K	1	MR25	METAL FILM
R534	5322 116 50559	27,4K	1	MR25	METAL FILM
R535	5322 116 50669	205	1	MR25	METAL FILM
R536	5322 116 50608	6,19K	1	MR25	METAL FILM
R537	5322 116 54005	3,32K	1	MR25	METAL FILM
R538	5322 116 54623	11K	1	MR25	METAL FILM
R540	5322 116 50536	464	1	MR25	METAL FILM
R541	5322 116 54689	82,5K	1	MR25	METAL FILM
R542	5322 116 50536	464	1	MR25	METAL FILM
R543	5322 116 54623	11K	1	MR25	METAL FILM
R544	5322 116 50557	46,4K	1	MR25	METAL FILM
R546	5322 116 54627	13,3K	1	MR25	METAL FILM
R547	5322 101 14069	22K	20	0,5	CARBON TRIMMING POTM
R548	5322 116 54576	2,37K	1	MR25	METAL FILM
R549	5322 116 50608	6,19K	1	MR25	METAL FILM
R551	5322 116 54005	3,32K	1	MR25	METAL FILM
R552	5322 116 54623	11K	1	MR25	METAL FILM
R553	5322 116 54689	82,5K	1	MR25	METAL FILM
R554	5322 116 54623	11K	1	MR25	METAL FILM
R555	5322 116 50536	464	1	MR25	METAL FILM
R556	5322 116 50557	46,4K	1	MR25	METAL FILM
R557	5322 116 50536	464	1	MR25	METAL FILM
R558	5322 116 50557	46,4K	1	MR25	METAL FILM
R559	5322 116 54623	11K	1	MR25	METAL FILM
R560	5322 116 54743	301K	1	MR25	METAL FILM
R561	5322 116 54619	10K	1	MR25	METAL FILM
R562	5322 116 54641	19,6K	1	MR25	METAL FILM
R563	5322 116 50729	4,22K	1	MR25	METAL FILM
R564	4822 110 63187	1M	5	CR25	CARBON
R565	5322 116 50747	1K	1	MR25	METAL FILM
R566	4822 110 63187	1M	5	CR25	CARBON
R567	4822 110 63161	100K	5	CR25	CARBON
R568	5322 101 14094	1M	20	0,5	CARBON TRIMMING POTM
R569R571	4822 110 63187	1M	5	CR25	CARBON
R572	5322 116 54676	10K	1	MR25	METAL FILM
R573	4822 110 42223	22M	5	VR37	CARBON
SELECT ON TEST	R574R576				
R574	4822 110 42216	12M	5	VR37	CARBON
R575	4822 110 63161	100K	5	CR25	CARBON
R576	4822 110 42205	4,7M	5	VR37	CARBON
R577R578	4822 110 63196	2,2M	10	CR25	CARBON
R579	5322 101 14094	1M	20	0,5	CARBON TRIMMING POTM
R580	5322 116 50747	1K	1	MR25	METAL FILM
R581	5322 116 54619	10K	1	MR25	METAL FILM

ITEM	ORDERING NUMBER	OHM	TOL (%)	TYPE	REMARKS
R582R583	5322 116 54701	110K	1	MR25	METAL FILM
R584	5322 116 54674	53,6K	1	MR25	METAL FILM
R585	5322 116 50491	22,6	1	MR25	METAL FILM
R586	5322 116 54674	53,6K	1	MR25	METAL FILM
R587..89	5322 101 14048	47K	20	0,5	CARBON TRIMMING POTM
R591	5322 116 54469	100	1	MR25	METAL FILM
R592	5322 116 54492	178	1	MR25	METAL FILM
R593	5322 116 50904	30,1	1	MR25	METAL FILM
R594	4822 110 43107	1K	5	CR52	CARBON
R596	5322 116 50675	2,26K	1	MR25	METAL FILM
R600	5322 116 54435	24	5	CR16	METAL FILM
R600	5322 116 51052	42,2	1	MR25	METAL FILM
R601	5322 116 54195	825K	1	MR30	METAL FILM
R602	5322 116 54721	178K	1	MR25	METAL FILM
R605	5322 116 54619	10K	1	MR25	METAL FILM
R606R607	4822 110 63207	5,6M	10	CR25	CARBON
R608	4822 111 30324	100	5	CR16	CARBON
R609	5322 111 30396	22	5	CR16	CARBON
R610	5322 116 54619	10K	1	MR25	METAL FILM
R611	5322 116 54558	8,25K	1	MR25	METAL FILM
R612	5322 116 54515	348	1	MR25	METAL FILM
R612	5322 116 54469	100	1	MR25	METAL FILM
R613	5322 116 54541	825	1	MR25	METAL FILM
R614	5322 116 50506	154	1	MR25	METAL FILM
R616	5322 116 54619	10K	1	MR25	METAL FILM
R617	5322 116 50481	22,6K	1	MR25	METAL FILM
R618	5322 116 54529	619	1	MR25	METAL FILM
R619	4822 111 30348	27	5	CR16	CARBON
R621	5322 111 30396	22	5	CR16	CARBON
R622	4822 111 30067	33	5	CR16	CARBON
R623	5322 116 54459	75	1	MR25	METAL FILM
R623	5322 116 54455	68,1	1	MR25	METAL FILM
R624	4822 111 30067	33	5	CR16	CARBON
R626	5322 116 54469	100	1	MR25	METAL FILM
R627	5322 116 54529	619	1	MR25	METAL FILM
R628	5322 116 54534	681	1	MR25	METAL FILM
R629	5322 116 54426	121	1	MR25	METAL FILM
R631	5322 101 14011	100	20	0,5	CARBON TRIMMING POTM
R632	5322 111 30278	27K	5	CR16	CARBON
R633	4822 111 30348	27	5	CR16	CARBON
R634	5322 116 54469	100	1	MR25	METAL FILM
R634	5322 116 54515	348	1	MR25	METAL FILM
R635	5322 111 30074	56	5	CR16	CARBON
R636	5322 100 10113	10K	20	0,5	CARBON TRIMMING POTM
R637	5322 116 50524	3,01K	1	MR25	METAL FILM
R638	4822 111 30067	33	5	CR16	CARBON
R639	5322 116 54534	681	1	MR25	METAL FILM
R641	5322 116 50561	590	1	MR25	METAL FILM
R642	5322 116 54469	100	1	MR25	METAL FILM
R643	4822 111 30067	33	5	CR16	CARBON
R644	5322 116 50524	3,01K	1	MR25	METAL FILM
R645	5322 111 30074	56	5	CR16	CARBON
R646	5322 116 50524	3,01K	1	MR25	METAL FILM
R647	4822 111 30348	27	5	CR16	CARBON
R648	4822 111 30067	33	5	CR16	CARBON
R649	5322 116 54469	100	1	MR25	METAL FILM
R650	5322 111 30074	56	5	CR16	CARBON
R651	5322 116 50561	590	1	MR25	METAL FILM
R652	4822 111 30067	33	5	CR16	CARBON
R653	5322 116 54534	681	1	MR25	METAL FILM
R654	5322 116 50524	3,01K	1	MR25	METAL FILM
R655	5322 111 30074	56	5	CR16	CARBON
R656	5322 100 10113	10K	20	0,5	CARBON TRIMMING POTM
R657	5322 116 50506	154	1	MR25	METAL FILM
R658	4822 111 30348	27	5	CR16	CARBON
R669	5322 116 50524	3,01K	1	MR25	METAL FILM
R671	4822 111 30067	33	5	CR16	CARBON
R672	5322 116 54469	100	1	MR25	METAL FILM
R673	5322 116 50561	590	1	MR25	METAL FILM
R674	4822 111 30067	33	5	CR16	CARBON

ITEM	ORDERING NUMBER	OHM	TOL (%)	TYPE	REMARKS
R676	5322 116 54534	681	1	MR25	METAL FILM
R677	5322 116 50491	22,6	1	MR25	METAL FILM
R678	5322 116 50524	3,01K	1	MR25	METAL FILM
R679	5322 116 54696	100K	1	MR25	METAL FILM
R680	5322 111 30396	22	5	CR16	CARBON
R681	5322 116 50524	3,01K	1	MR25	METAL FILM
R682	5322 116 54541	825	1	MR25	METAL FILM
R683	5322 116 50557	46,4K	1	MR25	METAL FILM
R684	5322 116 54011	5,62K	1	MR25	METAL FILM
R685	5322 116 50491	22,6	1	MR25	METAL FILM
R686	5322 116 54696	100K	1	MR25	METAL FILM
R687	5322 116 54228	1,78K	1	MR25	METAL FILM
R688	5322 116 50767	2,15K	1	MR25	METAL FILM
R689R691	5322 116 50747	1K	1	MR25	METAL FILM
R692	5322 116 50484	4,64K	1	MR25	METAL FILM
R693	5322 116 54619	10K	1	MR25	METAL FILM
R694	5322 116 50747	1K	1	MR25	METAL FILM
R696	5322 116 54228	1,78K	1	MR25	METAL FILM
R697	5322 116 50767	2,15K	1	MR25	METAL FILM
R698	5322 116 50524	3,01K	1	MR25	METAL FILM
R699	5322 116 54541	825	1	MR25	METAL FILM
R700	5322 111 30396	22	5	CR16	CARBON
R701	5322 116 54529	619	1	MR25	METAL FILM
R702	5322 116 54536	750	1	MR25	METAL FILM
R703	5322 116 50842	1,1K	1	MR25	METAL FILM
R704	5322 111 30396	22	5	CR16	CARBON
R705	5322 116 50491	22,6	1	MR25	METAL FILM
R706	4822 111 30067	33	5	CR16	CARBON
R707	5322 116 54529	619	1	MR25	METAL FILM
R707	5322 116 54587	3,65K	1	MR25	METAL FILM
R708	5322 116 50572	12,1K	1	MR25	METAL FILM
R708	5322 116 50664	2,05K	1	MR25	METAL FILM
R709	5322 100 10113	10K	20	0,5	CARBON TRIMMING POTM
R711	5322 116 50747	1K	1	MR25	METAL FILM
R712	5322 101 14047	470	20	0,5	CARBON TRIMMING POTM
R713	5322 116 54619	10K	1	MR25	METAL FILM
R714	5322 116 50586	1,54	1	MR25	METAL FILM
R716	5322 116 50484	4,64K	1	MR25	METAL FILM
R717	5322 116 50747	1K	1	MR25	METAL FILM
R718	5322 116 50586	1,54K	1	MR25	METAL FILM
R719	5322 116 54587	3,65K	1	MR25	METAL FILM
R719	5322 116 54529	619	1	MR25	METAL FILM
R721	5322 116 54529	619	1	MR25	METAL FILM
R722	5322 116 50664	2,05K	1	MR25	METAL FILM
R722	5322 116 50572	12,1K	1	MR25	METAL FILM
R723	5322 116 50747	1K	1	MR25	METAL FILM
R724	5322 116 54529	619	1	MR25	METAL FILM
R726	5322 116 54536	750	1	MR25	METAL FILM
R727	5322 111 30396	22	5	CR16	CARBON
R728	4822 111 30067	33	5	CR16	CARBON
R729	5322 116 50842	1,1K	1	MR25	METAL FILM
R731	5322 111 30396	22	5	CR16	CARBON
R732	4822 111 30352	82	5	CR16	CARBON
R733	5322 111 30396	22	5	CR16	CARBON
R734	5322 116 54585	3,48K	1	MR25	METAL FILM
R736	5322 116 54592	4,02K	1	MR25	METAL FILM
R737	5322 101 14069	22K	20	0,5	CARBON TRIMMING POTM
R738	5322 116 50479	15,4K	1	MR25	METAL FILM
R739	5322 116 54228	1,78K	1	MR25	METAL FILM
R741	5322 116 54558	8,25K	1	MR25	METAL FILM
R742	5322 116 50747	1K	1	MR25	METAL FILM
R743	5322 116 54469	100	1	MR25	METAL FILM
R744	5322 116 54592	4,02K	1	MR25	METAL FILM
R746R747	5322 111 44153	15	5	CR16	CARBON
R748R749	5322 116 54515	348	1	MR25	METAL FILM
R751R752	5322 111 44153	15	5	CR16	CARBON
R753,754	5322 111 30396	22	5	CR16	CARBON
R756	4822 111 30352	82	5	CR16	CARBON
R757	5322 116 50572	12,1K	1	MR25	METAL FILM
R758	5322 116 50524	3,01K	1	MR25	METAL FILM

ITEM	ORDERING NUMBER	OHM	TOL (%)	TYPE	REMARKS
R759	5322 116 50484	4,64K	1	MR25	METAL FILM
R761	5322 116 54508	301	1	MR25	METAL FILM
R762	5322 116 54565	1,62K	1	MR25	METAL FILM
R763	4822 111 30272	680	5	CR16	CARBON
R764R765	4822 111 30324	100	5	CR16	CARBON
R766	4822 111 30272	680	5	CR16	CARBON
R767..71	4822 110 63036	2,2	5	CR25	CARBON
R801	4822 111 30347	10	5	CR16	CARBON
R802	5322 116 50904	30,1	1	MR25	METAL FILM
R803	5322 116 54508	301	1	MR25	METAL FILM
R804	5322 116 50675	2,26K	1	MR25	METAL FILM
R805	5322 116 54624	11,5K	1	MR25	METAL FILM
R806	5322 100 10113	10K	20	0,5	CARBON TRIMMING POTM
R807	5322 116 54619	10K	1	MR25	METAL FILM
R808	5322 116 50414	2,87K	1	MR25	METAL FILM
R809	5322 116 50509	4,87K	1	MR25	METAL FILM
R810	5322 116 54511	316	1	MR25	METAL FILM
R811	5322 116 54587	3,65K	1	MR25	METAL FILM
R812	5322 116 54442	51,1	1	MR25	METAL FILM
R813	5322 116 50583	5,9K	1	MR25	METAL FILM
R813	5322 116 54558	8,25K	1	MR25	METAL FILM
R814	5322 116 54442	51,1	1	MR25	METAL FILM
R815	5322 116 54532	649	1	MR25	METAL FILM
R816	5322 116 54696	100K	1	MR25	METAL FILM
R817	5322 116 54619	10K	1	MR25	METAL FILM
R818	5322 116 54565	1,62K	1	MR25	METAL FILM
R818	5322 116 50779	1,33K	1	MR25	METAL FILM
R819	5322 116 54442	51,1	1	MR25	METAL FILM
R820	5322 116 50579	3,16K	1	MR25	METAL FILM
R821	5322 116 54543	215	1	MR25	METAL FILM
R821	5322 116 54497	226	1	MR25	METAL FILM
R822R823	5322 116 50491	22,6	1	MR25	METAL FILM
R824	5322 116 54595	5,11K	1	MR25	METAL FILM
R826	4822 111 30067	33	5	CR16	CARBON
R827	5322 116 54619	10K	1	MR25	METAL FILM
R828	5322 116 54608	7,5K	1	MR25	METAL FILM
R829	5322 116 50664	2,05K	1	MR25	METAL FILM
R831	5322 116 50636	2,74K	1	MR25	METAL FILM
R834	5322 100 10114	4,7K	20	0,5	CARBON TRIMMING POTM
R836	5322 116 54204	22,6K	1	MR25	METAL FILM
R837	5322 116 54632	14,7K	1	MR25	METAL FILM
R838	5322 116 54721	178K	1	MR25	METAL FILM
R839	5322 116 54479	127	1	MR25	METAL FILM
R841	5322 116 50479	15,4K	1	MR25	METAL FILM
R842	5322 116 54635	16,9K	1	MR25	METAL FILM
R843	5322 116 54635	16,9K	1	MR25	METAL FILM
R844	5322 116 50675	2,26K	1	MR25	METAL FILM
R846	5322 116 50457	215	1	MR25	METAL FILM
R847	5322 116 50414	2,87K	1	MR25	METAL FILM
R848	5322 116 50509	4,87K	1	MR25	METAL FILM
R849	5322 116 54562	1,4K	1	MR25	METAL FILM
R850	5322 116 54009	562	1	MR25	METAL FILM
R851	5322 116 54519	402	1	MR25	METAL FILM
R852	5322 116 54532	649	1	MR25	METAL FILM
R853	5322 116 54228	1,78K	1	MR25	METAL FILM
R854	5322 116 50491	22,6	1	MR25	METAL FILM
R855	5322 116 50559	27,4K	1	MR25	METAL FILM
R856R857	5322 116 54009	562	1	MR25	METAL FILM
R858R859	5322 116 50559	27,4K	1	MR25	METAL FILM
R860..62	5322 116 50675	2,26K	1	MR25	METAL FILM
R863..65	5322 116 50636	2,74K	1	MR25	METAL FILM
R866	5322 116 54192	5,11	1	MR25	METAL FILM
R866	5322 116 50452	10	1	MR25	METAL FILM
R867	5322 116 50491	22,6	1	MR25	METAL FILM
R868	5322 116 54641	19,6K	1	MR25	METAL FILM
R869	5322 116 54585	3,48K	1	MR25	METAL FILM
R870	5322 116 54005	3,32K	1	MR25	METAL FILM
R871	5322 116 54661	34,8K	1	MR25	METAL FILM
R872	5322 116 50726	36,5K	1	MR25	METAL FILM

ITEM	ORDERING NUMBER	OHM	TOL (%)	TYPE	REMARKS
R873R874	5322 116 50491	22,6	1	MR25	METAL FILM
R875	4822 111 30311	3,9K	5	CR16	CARBON
R876	4822 111 30245	47	5	CR16	CARBON
R877	4822 111 30352	82	5	CR16	CARBON
R878	5322 111 30279	33K	5	CR16	CARBON
R881	5322 116 54655	30,1K	1	MR25	METAL FILM
R889	5322 116 54619	10K	1	MR25	METAL FILM
R891	5322 116 50508	487	1	MR25	METAL FILM
R893	5322 116 54637	17,8K	1	MR25	METAL FILM
R894	5322 116 50572	12,1K	1	MR25	METAL FILM
R896	5322 116 54689	82,5K	1	MR25	METAL FILM
R897	5322 116 54608	7,5K	1	MR25	METAL FILM
R898	5322 116 50767	2,15K	1	MR25	METAL FILM
R899	5322 116 54643	20,5K	1	MR25	METAL FILM
R901,,04	4822 110 63036	2,2	5	CR25	CARBON
R921	5322 116 54902	876K	1/4	MR54C	METAL FILM
R922	5322 116 54901	887K	1/4	MR54C	METAL FILM
R923	5322 116 54896	354K	1/4	MR34C	METAL FILM
R924	5322 116 54899	176K	1/4	MR34C	METAL FILM
R926	5322 116 54897	87,6K	1/4	MR24C	METAL FILM
R927	5322 116 54895	34,6K	1/4	MR24C	METAL FILM
R928	5322 116 54894	16,8K	1/4	MR24C	METAL FILM
R929	5322 116 50809	7,96K	1/4	MR24C	METAL FILM
R931	5322 116 50867	2,67K	1/4	MR24C	METAL FILM
R932	5322 116 54898	887	1/4	MR24C	METAL FILM
R1000	5322 116 54435	24	5	CR16	METAL FILM
R1000	5322 116 51052	42,2	1	MR25	METAL FILM
R1001	5322 116 54195	825K	1	MR30	METAL FILM
R1002	5322 116 54721	178K	1	MR25	METAL FILM
R1005	5322 116 54619	10K	1	MR25	METAL FILM
R1006,07	4822 110 63207	5,6M	10	CR25	CARBON
R1008	4822 111 30324	100	5	CR16	CARBON
R1009	5322 111 30396	22	5	CR16	CARBON
R1010	5322 116 54619	10K	1	MR25	METAL FILM
R1013	5322 116 54541	825	1	MR25	METAL FILM
R1014	5322 116 50506	154	1	MR25	METAL FILM
R1018	5322 116 54529	619	1	MR25	METAL FILM
R1019	4822 111 30348	27	5	CR16	CARBON
R1021	5322 111 30396	22	5	CR16	CARBON
R1022	4822 111 30067	33	5	CR16	CARBON
R1023	5322 116 54459	75	1	MR25	METAL FILM
R1023	5322 116 54455	68,1	1	MR25	METAL FILM
R1024	4822 111 30067	33	5	CR16	CARBON
R1026	5322 116 54469	100	1	MR25	METAL FILM
R1027	5322 116 54529	619	1	MR25	METAL FILM
R1028	5322 116 54534	681	1	MR25	METAL FILM
R1029	5322 116 54426	121	1	MR25	METAL FILM
R1031	5322 101 14011	100	20	0,5	CARBON TRIMMING POTM
R1032	5322 111 30278	27K	5	CR16	CARBON
R1033	4822 111 30348	27	5	CR16	CARBON
R1035	5322 111 30074	56	5	CR16	CARBON
R1036	5322 100 10113	10K	20	0,5	CARBON TRIMMING POTM
R1037	5322 116 50524	3,01K	1	MR25	METAL FILM
R1038	4822 111 30067	33	5	CR16	CARBON
R1039	5322 116 54534	681	1	MR25	METAL FILM
R1041	5322 116 54534	681	1	MR25	METAL FILM
R1041	5322 116 50561	590	1	MR25	METAL FILM
R1042	5322 116 54469	100	1	MR25	METAL FILM
R1043	4822 111 30067	33	5	CR16	CARBON
R1044,46	5322 116 50524	3,01K	1	MR25	METAL FILM
R1045	5322 111 30074	56	5	CR16	CARBON
R1047	4822 111 30348	27	5	CR16	CARBON
R1048	4822 111 30067	33	5	CR16	CARBON
R1049	5322 116 54469	100	1	MR25	METAL FILM
R1050	5322 111 30074	56	5	CR16	CARBON
R1051	5322 116 54534	681	1	MR25	METAL FILM
R1051	5322 116 50561	590	1	MR25	METAL FILM
R1052	4822 111 30067	33	5	CR16	CARBON
R1053	5322 116 54534	681	1	MR25	METAL FILM
R1054	5322 116 50524	3,01K	1	MR25	METAL FILM

ITEM	ORDERING NUMBER	OHM	TOL (%)	TYPE	REMARKS
R1055	5322 111 30074	56	5	CR16	CARBON
R1056	5322 100 10113	10K	20	0,5	CARBON TRIMMING POTM
R1057	5322 116 50506	154	1	MR25	METAL FILM
R1058	4822 111 30348	27	5	CR16	CARBON
R1079	5322 116 54696	100K	1	MR25	METAL FILM
R1080	5322 111 30396	22	5	CR16	CARBON
R1081	5322 116 50524	3,01K	1	MR25	METAL FILM
R1082	5322 116 54541	825	1	MR25	METAL FILM
R1083	5322 116 50557	46K4	1	MR25	METAL FILM
R1084	5322 116 54011	5K62	1	MR25	METAL FILM
R1086	5322 116 54696	100K	1	MR25	METAL FILM
R1087	5322 116 54228	1,78K	1	MR25	METAL FILM
R1088	5322 116 50767	2,15K	1	MR25	METAL FILM
R1089,91	5322 116 50747	1K	1	MR25	METAL FILM
R1092	5322 116 50484	4,64K	1	MR25	METAL FILM
R1093	5322 116 54619	10K	1	MR25	METAL FILM
R1094	5322 116 50747	1K	1	MR25	METAL FILM
R1096	5322 116 54228	1,78K	1	MR25	METAL FILM
R1097	5322 116 50767	2,15K	1	MR25	METAL FILM
R1097	5322 116 50524	3,01K	1	MR25	METAL FILM
R1099	5322 116 54541	825	1	MR25	METAL FILM
R1100	5322 111 30396	22	5	CR16	CARBON
R1101	5322 116 54529	619	1	MR25	METAL FILM
R1102	5322 116 54536	750	1	MR25	METAL FILM
R1103	5322 116 50842	1,1K	1	MR25	METAL FILM
R1104	5322 111 30396	22	5	CR16	CARBON
R1105	5322 116 50491	22,6	1	MR25	METAL FILM
R1106	4822 111 30067	33	5	CR16	CARBON
R1107	5322 116 54529	619	1	MR25	METAL FILM
R1108	5322 116 50572	12,1K	1	MR25	METAL FILM
R1109	5322 100 10113	10K	20	0,5	CARBON TRIMMING POTM
R1111	5322 116 50747	1K	1	MR25	METAL FILM
R1112	5322 101 14047	470	20	0,5	CARBON TRIMMING POTM
R1113	5322 116 54619	10K	1	MR25	METAL FILM
R1114	5322 116 50586	1,54K	1	MR25	METAL FILM
R1116	5322 116 50484	4,64K	1	MR25	METAL FILM
R1117	5322 116 50747	1K	1	MR25	METAL FILM
R1118	5322 116 50586	1,54K	1	MR25	METAL FILM
R1119	5322 116 54587	3,65K	1	MR25	METAL FILM
R1121	5322 116 54529	619	1	MR25	METAL FILM
R1122	5322 116 50635	1,47K	1	MR25	METAL FILM
R1122	5322 116 50664	2,05K	1	MR25	METAL FILM
R1123	5322 116 50747	1K	1	MR25	METAL FILM
R1124	5322 116 54529	619	1	MR25	METAL FILM
R1125	5322 116 50491	22,6	1	MR25	METAL FILM
R1126	5322 116 54536	750	1	MR25	METAL FILM
R1127	5322 111 30396	22	5	CR16	CARBON
R1128	4822 111 30067	33	5	CR16	CARBON
R1129	5322 116 50842	1,1K	1	MR25	METAL FILM
R1131	5322 111 30396	22	5	CR16	CARBON
R1132	4822 111 30352	82	5	CR16	CARBON
R1133	5322 111 30396	22	5	CR16	CARBON
R1134	5322 116 54585	3,48K	1	MR25	METAL FILM
R1136	5322 116 54592	4,02K	1	MR25	METAL FILM
R1137	5322 101 14069	22K	20	0,5	CARBON TRIMMING POTM
R1138	5322 116 50479	15,4K	1	MR25	METAL FILM
R1139	5322 116 54228	1,78K	1	MR25	METAL FILM
R1141	5322 116 54558	8,25K	1	MR25	METAL FILM
R1142	5322 116 50747	1K	1	MR25	METAL FILM
R1143	5322 116 54469	100	1	MR25	METAL FILM
R1144	5322 116 54592	4,02K	1	MR25	METAL FILM
R1146,47	5322 111 44153	15	5	CR16	CARBON
R1148,49	5322 116 54515	348	1	MR25	METAL FILM
R1151,52	5322 111 44153	15	5	CR16	CARBON
R1153,54	5322 111 30396	22	5	CR16	CARBON
R1156	4822 111 30352	82	5	CR16	CARBON
R1157	5322 116 50572	12,1K	1	MR25	METAL FILM
R1158	5322 116 50524	3,01K	1	MR25	METAL FILM
R1159	5322 116 50484	4,64K	1	MR25	METAL FILM
R1160	5322 116 54469	100	1	MR25	METAL FILM

ITEM	ORDERING NUMBER	OHM	TOL (%)	TYPE	REMARKS
R1161	5322 116 54508	301	1	MR25	METAL FILM
R1162	5322 116 54565	1,62K	1	MR25	METAL FILM
R1167,71	4822 110 63036	2,2	5	CR25	CARBON
R1201	5322 111 44153	15	5	CR16	CARBON
R1201	4822 111 30347	10	5	CR16	CARBON
R1202	5322 116 54446	56,2	1	MR25	METAL FILM
R1202	5322 116 50904	30,1	1	MR25	METAL FILM
R1203	5322 116 54508	301	1	MR25	METAL FILM
R1204	5322 116 50675	2,26K	1	MR25	METAL FILM
R1206	5322 100 10113	10K	20	0,5	CARBON TRIMMING POTM
R1207	5322 116 54619	10K	1	MR25	METAL FILM
R1208	5322 116 54617	9,53K	1	MR25	METAL FILM
R1209	5322 116 50509	4,87K	1	MR25	METAL FILM
R1211	5322 116 54547	953	1	MR25	METAL FILM
R1212	5322 116 54442	51,1	1	MR25	METAL FILM
R1213	5322 116 50583	5,9K	1	MR25	METAL FILM
R1213	5322 116 54558	8,25K	1	MR25	METAL FILM
R1214	5322 116 54442	51,1	1	MR25	METAL FILM
R1215	5322 116 54532	649	1	MR25	METAL FILM
R1216	5322 116 54228	1,78K	1	MR25	METAL FILM
R1219	5322 116 54442	51,1	1	MR25	METAL FILM
R1220	5322 116 50579	3,16K	1	MR25	METAL FILM
R1221	5322 116 50457	215	1	MR25	METAL FILM
R1221	5322 116 54497	226	1	MR25	METAL FILM
R1222,23	5322 116 50491	22,6	1	MR25	METAL FILM
R1224	5322 116 54595	5,11K	1	MR25	METAL FILM
R1225	5322 116 54009	562	1	MR25	METAL FILM
R1226	5322 116 54689	82,5K	1	MR25	METAL FILM
R1227	5322 100 10113	10K	20	0,5	CARBON TRIMMING POTM
R1228	4822 111 30067	33	5	CR16	CARBON
R1229	5322 116 54619	10K	1	MR25	METAL FILM
R1230	5322 116 50559	27,4K	1	MR25	METAL FILM
R1231	5322 116 50636	2,74K	1	MR25	METAL FILM
R1232	5322 116 54608	7,5K	1	MR25	METAL FILM
R1233	5322 116 50664	2,05K	1	MR25	METAL FILM
R1234	5322 100 10114	4,7K	20	0,5	CARBON TRIMMING POTM
R1235	5322 116 50675	2,26K	1	MR25	METAL FILM
R1236	5322 116 50481	22,6K	1	MR25	METAL FILM
R1237	5322 116 54009	562	1	MR25	METAL FILM
R1238	5322 116 50559	27,4K	1	MR25	METAL FILM
R1239	5322 116 50675	2,26K	1	MR25	METAL FILM
R1241	5322 116 54009	562	1	MR25	METAL FILM
R1242	5322 116 50559	27,4K	1	MR25	METAL FILM
R1243	5322 116 50675	2,26K	1	MR25	METAL FILM
R1244,46	5322 116 50491	22,6	1	MR25	METAL FILM
R1247	4822 111 30245	47	5	CR16	CARBON
R1248	4822 111 30352	82	5	CR16	CARBON
R1249	5322 111 30279	33K	5	CR16	CARBON
R1251	5322 116 54655	30,1K	1	MR25	METAL FILM
R1252	5322 116 50457	215	1	MR25	METAL FILM
R1253	5322 116 50414	2,87K	1	MR25	METAL FILM
R1254	5322 116 50675	2,26K	1	MR25	METAL FILM
R1256	5322 116 50509	4,87K	1	MR25	METAL FILM
R1257	5322 116 54562	1,4K	1	MR25	METAL FILM
R1258	5322 116 54519	402	1	MR25	METAL FILM
R1259	5322 116 54511	316	1	MR25	METAL FILM
R1261	5322 116 54576	2,37K	1	MR25	METAL FILM
R1262	5322 116 54508	301	1	MR25	METAL FILM
R1263	5322 116 54011	5,62K	1	MR25	METAL FILM
R1264	5322 116 54567	1,69K	1	MR25	METAL FILM
R1266	5322 111 30396	22	5	CR16	CARBON
R1267	5322 116 50482	33,2K	1	MR25	METAL FILM
R1268	5322 116 54608	7,5K	1	MR25	METAL FILM
R1269	5322 111 30396	22	5	CR16	CARBON
R1271	5322 116 50491	22,6	1	MR25	METAL FILM
R1272	5322 116 54592	4,02K	1	MR25	METAL FILM
R1273	5322 116 54641	19,6K	1	MR25	METAL FILM
R1274	5322 116 54525	511	1	MR25	METAL FILM

ITEM	ORDERING NUMBER	OHM	TOL (%)	TYPE	REMARKS
R1276,79	4822 110 63036	2,2	5	CR25	CARBON
R1281,82	4822 111 30327	220	5	CR16	CARBON
R1302	5322 116 54901	887K	1/4	MR54C	METAL FILM
R1303	5322 116 54896	354K	1/4	MR34C	METAL FILM
R1304	5322 116 54899	176K	1/4	MR34C	METAL FILM
R1306	5322 116 54897	87,6K	1/4	MR24C	METAL FILM
R1307	5322 116 54895	34,6K	1/4	MR24C	METAL FILM
R1308	5322 116 54894	16,8K	1/4	MR24C	METAL FILM
R1309	5322 116 50809	7,96K	1/4	MR24C	METAL FILM
R1311	5322 116 50867	2,67K	1/4	MR24C	METAL FILM
R1312	5322 116 54898	887	1/4	MR24C	METAL FILM
R1413	5322 116 54012	6,81K	1	MR25	METAL FILM
R1401	5322 100 10113	10K	20	0,5	CARBON TRIMMING POTM
R1402	5322 116 50557	46,4K	1	MR25	METAL FILM
R1403	5322 116 54558	8,25K	1	MR25	METAL FILM
R1404	5322 116 54515	348	1	MR25	METAL FILM
R1406	5322 116 54009	562	1	MR25	METAL FILM
R1407	5322 116 50484	4,64K	1	MR25	METAL FILM
R1408	5322 116 54502	261	1	MR25	METAL FILM
R1409	5322 116 50731	10,5K	1	MR25	METAL FILM
R1411	5322 116 50671	2,61K	1	MR25	METAL FILM
R1412	5322 116 50457	215	1	MR25	METAL FILM
R1413	5322 116 54012	6,81K	1	MR25	METAL FILM
R1414	5322 116 50747	1K	1	MR25	METAL FILM
R1416	5322 116 50557	46,4K	1	MR25	METAL FILM
R1417	5322 116 50872	61,9K	1	MR25	METAL FILM
R1418	5322 116 50557	46,4K	1	MR25	METAL FILM
R1419	5322 100 10113	10K	20	0,5	CARBON TRIMMING POTM
R1412,24	5322 116 54541	825	1	MR25	METAL FILM
R1426,28	5322 116 50664	2,05K	1	MR25	METAL FILM
R1429	5322 116 54595	5,11K	1	MR25	METAL FILM
R1431,32	5322 116 54619	10K	1	MR25	METAL FILM
R1433	5322 116 50636	2,74K	1	MR25	METAL FILM
R1434	5322 116 54619	10K	1	MR25	METAL FILM
R1436	5322 116 54005	3,32K	1	MR25	METAL FILM
R1437	5322 116 50572	12,1K	1	MR25	METAL FILM
R1438	5322 116 50842	1,1K	1	MR25	METAL FILM
R1439	5322 116 54637	17,8K	1	MR25	METAL FILM
R1442,43	5322 111 30396	22	5	CR16	CARBON
R1444	5322 100 10143	1K	20	0,75	CARBON TRIMMING POTM
R1445	5322 116 50457	215	1	MR25	METAL FILM
R1446	5322 116 54516	365	1	MR25	METAL FILM
R1447	5322 116 50635	1,47K	1	MR25	METAL FILM
R1448	5322 116 54635	16,9K	1	MR25	METAL FILM
R1449	5322 116 54643	20,5K	1	MR25	METAL FILM
R1451	5322 116 54515	348	1	MR25	METAL FILM
R1452,53	5322 116 54592	4,02K	1	MR25	METAL FILM
R1454,56	5322 116 54516	365	1	MR25	METAL FILM
R1457	5322 116 54619	10K	1	MR25	METAL FILM
R1458	5322 116 54565	1,62K	1	MR25	METAL FILM
R1459	5322 116 54615	9,09K	1	MR25	METAL FILM
R1461	5322 116 54592	4,02K	1	MR25	METAL FILM
R1462	5322 100 10141	10K	20	0,75	CARBON TRIMMING POTM
R1463	5322 116 54648	24,9K	1	MR25	METAL FILM
R1464	5322 111 30396	22	5	CR16	CARBON
R1466	5322 116 54619	10K	1	MR25	METAL FILM
R1467	5322 111 30396	22	5	CR16	CARBON
R1468	5322 116 50509	4,87K	1	MR25	METAL FILM
R1471	5322 116 54529	619	1	MR25	METAL FILM
R1472	5322 116 54576	2,37K	1	MR25	METAL FILM
R1473	5322 116 50767	2,15K	1	MR25	METAL FILM
R1473	5322 116 50524	3,01K	1	MR25	METAL FILM
R1474	5322 111 30356	43	5	CR16	CARBON
R1476	5322 116 54442	51,1	1	MR25	METAL FILM
R1477	5322 116 50572	12,1K	1	MR25	METAL FILM
R1478	5322 116 50524	3,01K	1	MR25	METAL FILM
R1479	5322 116 54595	5,11K	1	MR25	METAL FILM
R1479	5322 116 54623	11K	1	MR25	METAL FILM
R1481	5322 116 54508	301	1	MR25	METAL FILM

ITEM	ORDERING NUMBER	OHM	TOL (%)	TYPE	REMARKS
R1482	5322 116 50636	2,74K	1	MR25	METAL FILM
R1483	5322 116 50572	12,1K	1	MR25	METAL FILM
R1484	5322 116 50524	3,01K	1	MR25	METAL FILM
R1486	5322 116 54508	301	1	MR25	METAL FILM
R1487	5322 116 54565	1,62K	1	MR25	METAL FILM
R1488	5322 116 54011	5,62K	1	MR25	METAL FILM
R1489	5322 111 30356	43	5	CR16	CARBON
R1491	5322 116 50767	2,15K	1	MR25	METAL FILM
R1491	5322 116 50524	3,01K	1	MR25	METAL FILM
R1492	5322 116 54595	5,11K	1	MR25	METAL FILM
R1492	5322 116 54623	11K	1	MR25	METAL FILM
R1493	4822 111 30324	100	5	CR16	CARBON
R1494	5322 116 54442	51,1	1	MR25	METAL FILM
R1496	5322 116 54508	301	1	MR25	METAL FILM
R1497	5322 116 50636	2,74K	1	MR25	METAL FILM
R1498	5322 100 10114	4,7K	20	0,5	CARBON TRIMMING POTM
R1499	5322 116 50636	2,74K	1	MR25	METAL FILM
R1501	5322 116 50559	27,4K	1	MR25	METAL FILM
R1502	5322 116 50583	5,9K	1	MR25	METAL FILM
R1513,14	5322 101 14069	22K	20	0,5	CARBON TRIMMING POTM
R1600	5322 116 54005	3,32K	1	MR25	METAL FILM
R1601	5322 116 50491	22,6	1	MR25	METAL FILM
R1602	5322 116 50608	6,19K	1	MR25	METAL FILM
R1603	5322 116 50636	2,74K	1	MR25	METAL FILM
R1604	5322 116 50636	2,74K	1	MR25	METAL FILM
R1605,06	5322 116 54466	90,9	1	MR25	METAL FILM
R1607	5322 116 54489	169	1	MR25	METAL FILM
R1608	5322 116 50675	2,26K	1	MR25	METAL FILM
R1609	5322 116 54567	1,69K	1	MR25	METAL FILM
R1610	5322 116 50484	4,64K	1	MR25	METAL FILM
R1611,14	5322 116 50636	2,74K	1	MR25	METAL FILM
R1626	5322 116 54595	5,11K	1	MR25	METAL FILM
R1627	5322 116 54008	4,75K	1	MR25	METAL FILM
R1628	5322 116 50568	4,99	1	MR25	METAL FILM
R1629	5322 116 54635	16,9K	1	MR25	METAL FILM
R1631,32	5322 116 54606	7,15K	1	MR25	METAL FILM
R1633,36	5322 116 54646	23,7K	1	MR25	METAL FILM
R1634	5322 116 50664	2,05K	1	MR25	METAL FILM
R1701	5322 116 54696	100K	1	MR25	METAL FILM
R1702	4822 111 30245	47	5	CR16	CARBON
R1703	5322 116 54009	562	1	MR25	METAL FILM
R1704	5322 116 50479	15,4K	1	MR25	METAL FILM
R1705	5322 116 50558	18,7K	1	MR25	METAL FILM
R1706	5322 111 30396	22	5	CR16	CARBON
R1707	5322 116 50479	15,4K	1	MR25	METAL FILM
R1708	5322 111 30396	22	5	CR16	CARBON
R1709	5322 116 50747	1K	1	MR25	METAL FILM
R1711	4822 110 63174	330K	5	CR25	CARBON
R1712	5322 111 30356	43	5	CR16	CARBON
R1713	5322 116 54557	1,21K	1	MR25	METAL FILM
R1714	5322 111 30356	43	5	CR16	CARBON
R1716	5322 116 54557	1,21K	1	MR25	METAL FILM
R1717	5322 116 50509	4,87K	1	MR25	METAL FILM
R1718	5322 116 54587	3,65K	1	MR25	METAL FILM
R1719	5322 116 50572	12,1K	1	MR25	METAL FILM
R1721	5322 111 30396	22	5	CR16	CARBON
R1722	5322 116 50479	15,4K	1	MR25	METAL FILM
R1723	5322 116 50747	1K	1	MR25	METAL FILM
R1724	4822 110 63165	150K	5	CR25	CARBON
R1726	5322 116 50479	15,4K	1	MR25	METAL FILM
R1727	5322 111 30396	22	5	CR16	CARBON
R1728	5322 116 54696	100K	1	MR25	METAL FILM
R1729	4822 111 30245	47	5	CR16	CARBON
R1730	5322 116 50558	18,7K	1	MR25	METAL FILM
R1731	5322 116 54009	562	1	MR25	METAL FILM
R1732	4822 110 63036	2,2	5	CR25	CARBON
R1733	4822 110 63036	2,2	5	CR25	CARBON
R1800	5322 116 54646	23,7K	1	MR25	METAL FILM
R1801	5322 113 60065	3,3	10	2	WIRE-WOUND

ITEM	ORDERING NUMBER	OHM	TOL (%)	TYPE	REMARKS
R1802	4822 111 30339	1	5	CR37	CARBON
R1803,04	5322 116 54721	178K	1	MR25	METAL FILM
R1805	5322 116 54643	20,5K	1	MR25	METAL FILM
R1806	4822 110 63196	2,2M	10	CR25	CARBON
R1807,08	4822 110 63176	390K	5	CR25	CARBON
R1809	5322 116 54696	100K	1	MR25	METAL FILM
R1810	5322 116 54698	105K	1	MR25	METAL FILM
R1811	5322 116 54188	1M	1	MR30	METAL FILM
R1812	5322 116 54683	68,1K	1	MR25	METAL FILM
R1813	5322 116 50726	36,5K	1	MR25	METAL FILM
R1814	5322 116 54069	12,1	1	MR25	METAL FILM
R1816	5322 116 54069	12,1	1	MR25	METAL FILM
R1817	5322 116 54637	17,8K	1	MR25	METAL FILM
R1818	5322 116 50843	110	1	MR30	METAL FILM
R1819	5322 116 54646	23,7K	1	MR25	METAL FILM
R1820	5322 116 50731	10,5K	1	MR25	METAL FILM
R1821	5322 116 50747	1K	1	MR25	METAL FILM
R1822	5322 116 50669	205	1	MR25	METAL FILM
R1823	5322 116 54557	1,21K	1	MR25	METAL FILM
R1824	5322 116 54589	3,83K	1	MR25	METAL FILM
R1826	5322 116 54574	2,21K	1	MR25	METAL FILM
R1827	5322 116 54558	8,25K	1	MR25	METAL FILM
R1828	5322 100 10115	1K	20	0,5	CARBON TRIMMING POTM
R1829	5322 116 50635	1,47K	1	MR25	METAL FILM
R1830	5322 116 50586	1,54K	1	MR25	METAL FILM
R1831	5322 116 54558	8,25K	1	MR25	METAL FILM
R1832	5322 116 54619	10K	1	MR25	METAL FILM
R1833	5322 116 54459	75	5	MR30	METAL FILM
R1834	5322 116 54689	82,5K	1	MR30	METAL FILM
R1836	4822 110 53187	1M	5	CR37	CARBON
R1837	5322 116 54676	56,2K	1	MR25	METAL FILM
R1838	5322 101 14066	10K	20	0,5	CARBON TRIMMING POTM
R1839	5322 116 54619	10K	1	MR25	METAL FILM
R1841,42	5322 116 54469	100	1	MR25	METAL FILM
R1843	4822 116 30041	4	20		NTC
R1901	5322 116 54469	100	1	MR25	METAL FILM
R1902	5322 116 54641	19,6K	1	MR25	METAL FILM
R1903	5322 116 50608	6,19K	1	MR25	METAL FILM
R1904	5322 116 54541	825	1	MR25	METAL FILM
R1906	5322 100 10114	4,7K	20	0,5	CARBON TRIMMING POTM
R1907	5322 116 54529	619	1	MR25	METAL FILM
R1908	5322 116 54576	2,37K	1	MR25	METAL FILM
R1909	5322 116 50608	6,19K	1	MR25	METAL FILM
R1911	5322 116 54524	499	1	MR25	METAL FILM
R1912	5322 116 54469	100	1	MR25	METAL FILM
R2000	4822 110 63194	1,8M	10	CR25	CARBON
R2001	5322 116 54005	3,32K	1	MR25	METAL FILM
R2002	4822 110 42187	1M	5	VR37	CARBON
R2003	4822 110 42189	1,2M	5	VR37	CARBON
R2004	5322 116 54619	10K	1	MR25	METAL FILM
R2005		SELECT	ON TEST		CARBON TRIMMING POTM
1,65 1	MR25 R2006				
R2007	5322 116 50492	46,4	1	MR25	METAL FILM
R2008	5322 116 50592	442	1	MR25	METAL FILM
R2012	5322 116 54683	68,1K	1	MR25	METAL FILM
R2013	5322 116 50636	2,74K	1	MR25	METAL FILM
SELECT ON TEST	R2014				
R2024	4822 110 42214	10M	5	VR37	CARBON

ELECTRICAL PARTS

TUBES VALVES

B1	5322 131 24022	CRT D14-240GH/08
B501,502	5322 131 90021	STAB.TUBE ZA1004

RELAYS

RE101,12	5322 281 64149	RELAY COIL
RE101,12	5322 280 24036	RELAY CONTACT

DIODES

Type	*Stamp if SOT-23*	*Ordering code*	*Encapsulation*
BA148		5322 130 30256	–
BA182		5322 130 30644	–
BAV45		5322 130 34037	TO-18
BAV70	A4	5322 130 34331	SOT-23
BAV99	A7	5322 130 34337	SOT-23
BAW62		5322 130 30613	–
BAX12		5322 130 30424	–
BAX17		5322 130 30605	–
BY187		5322 130 34136	–
BYX10		5322 130 34168	–
BYX55/600		4822 130 30817	–
BZX61/C33		5322 130 30786	–
BZX61/C75		5322 130 34034	–
BZX75/C1V4		5322 130 34047	–
BZX75/C2V1		5322 130 34049	–
BZX75/C3V6		5322 130 30765	–
BZX79/C4V7		4822 130 30773	–
BZX79/C5V1		5322 130 30767	–
BZX79/B5V6		5322 130 34173	–
BZX79/C5V6		5322 130 30759	–
BZX79/C6V8		5322 130 30768	–
BZX79/C9V1		5322 130 30667	–
BZX79/C10		5322 130 30774	–
BZX79/B30		5322 130 34328	–
BZX79/B39		5322 130 34145	–
BZX79/B43		5322 130 34329	–
BZX79/C47		5322 130 34168	–
BZX79/C62		5322 130 34165	–
BZY88/C3V3		5322 130 30392	–

INDUCTORS

Ordering code	*Description*	*Item*	*Qty*
5322 466 14121	Delay line	L301	1
5322 281 64154	Coil 144 μH [1]	L391	1
5322 466 14119	Filter (complete, for mounting see Fig. 3.31)	L401, 409	8

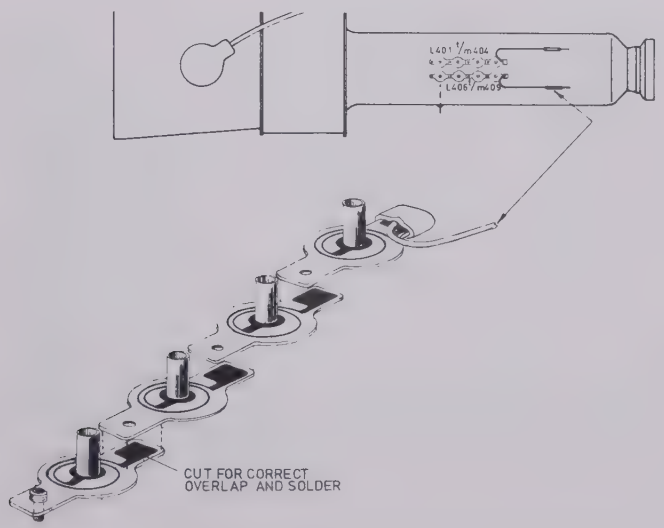


Fig. 3.31. C.r.t. Filter

[1] Coil 5322 281 64154 R = 0,29 Ω

Ordering code	*Description*	*Item*	*Qty*
5322 158 14121	Coil (comp) [2]	L411, 412	2
5322 150 14013	CRT corr. coil	L501	1
5322 281 64154	Coil 144 µH	L1601	1
5322 158 14026	Coil (comp)	L1801, 02	2
5322 281 64154	Coil 144 µH	L1803	1
5322 158 14086	Coil 22 mH	L1804	1
5322 158 10052	Coil	L1806	1
5322 281 64154	Coil 144 µH	L1807	1
5322 158 10052	Coil	L1808	1
5322 281 64154	Coil 144 µH	L1809	1
5322 158 10052	Coil	L1811	1
5322 281 64154	Coil 144 µH	L1812	1
5322 158 10052	Coil	L1813	1
5322 281 64154	Coil 144 µH	L1814	1
5322 158 10052	Coil	L1816	1
5322 281 64154	Coil 144 µH	L1817	1
5322 158 10052	Coil	L1818	1
5322 281 64154	Coil 144 µH	L1819	1
5322 158 10052	Coil	L1821	1
5322 281 64154	Coil 144 µH	L1822	1
5322 158 10052	Coil	L1823	1
5322 281 64154	Coil 144 µH	L1824	1
5322 158 10052	Coil	L1826	1
5322 281 64154	Coil 144 µH	L1827	1
5322 281 64154	Coil 144 µH	L2001	1

[2] These coils appertain to R418 and R427 in 200 ohm (grey) version.
In some PM 3260/01 sets, R418 and R427 consist of two 100 ohm (red) resistors in series; also L411 and L412 are then different. If one of these components must be replaced, both the resistors and the coils must be replaced.

LAMPS

Ordering code	*Type*	*Item*	*Qty*
5322 134 44017	Lamp type 394 12 V/40 mA	LA1, 2	2
5322 146 14069	Drive transformer	T1801	1
5322 142 64017	Chopper transformer	T1802	1
5322 142 64018	2 kV transformer	T2001	1

TRANSISTORS

Type	*Stamp, if SOT-23*	*Ordering code*	*Encapsulation*
BC547B		4822 130 40959	TO-92
BC548		4822 130 40938	TO-92
BC549		4822 130 40964	TO-92
BC549C		5322 130 44216	TO-92
BC557		4822 130 40973	TO-92
BC558		4822 130 40941	TO-92
BC558B		5322 130 44197	TO-92
BC559B		5322 130 44358	TO-92
BCW30	C2	5322 130 44335	SOT-23
BCW30R	C5	5322 130 44341	SOT-23
BCW33	D3	5322 130 44337	SOT-23

Type	*Stamp, if SOT-23*	*Ordering code*	*Encapsulation*
BCW33R	D6	5322 130 44342	SOT-23
BCY88		5322 130 30187	TO-71
BD135		5322 130 40645	TO-126
BD136		5322 130 40712	TO-126
BD262		5322 130 44357	TO-126
BF324		5322 130 44396	TO-92
BF336		5322 130 40908	TO-39
BFR64R		5322 130 44344	TO-117
BFS17	E1	5322 130 40781	SOT-23
BFS17R	E4	5322 130 44338	SOT-23
BFS19R	F5	5322 130 44339	SOT-23
BFW44		5322 130 40672	TO-39
BFY90		5322 130 40493	TO-72
BRY39		5322 130 40482	TO-72
BSS38		4822 130 40968	TO-92
BSV52	B2	5322 130 44336	SOT-23
BSV81		5322 130 44041	TO-72
BSW66		5322 130 40714	TO-39
BSX20		5322 130 40417	TO-18
BSX60		5322 130 44019	TO-39
BU108		5322 130 44182	TO-3
BU126		5322 130 44406 1)	TO-3
CNY23		5322 130 34378	
ON475	M1	5322 130 44343 2)	SOT-23
2N2894A		5322 130 44127	TO-18
537BSY	B3	5322 130 44359	SOT-23
537BSY-R	B6	5322 130 44356	SOT-23

1) Selected pair TS1803, TS1804.

2) Matched pair BFR30.

Ordering code	*Description*	*Code stamp*	*Item*	*Qty.*
Integrated circuits				
5322 209 84424	Impedance convertor	4022 105 25160*	IC101	2
5322 209 84427	Trigger amplifier	4022 105 25140	IC301, 351	2
5322 209 84425	Amplifier I	4022 105 25080	IC302, 352	2
5322 209 84112	Op. ampl.	TBA221/741C	IC303, 353	2
5322 209 84426	Amplifier II	4022 105 25100	IC304, 354	2
5322 209 84428	Channel selector	4022 105 25120	IC306	1
5322 209 84483	Delay line corr. ampl.	4022 105 25180	IC401	1
5322 209 84484	Final amplifier	4022 105 25200	IC402, 403	2
5322 209 84485	Trigger pulse shaper	4022 105 25220	IC601, 1001	2
5322 209 84143	Quad. 2 inp. NAND	FJH131/SN7400N	IC1601	1
5322 209 84414	Quad. 2 inp. NAND	FJH301/SN7426N	IC1602	1
5322 209 84166	JK m/s flip-flop	FJJ111/SN7472N	IC1603	1
5322 209 80245	Voltage regulator	TBA281/723C	IC1610, 1801	2
5322 209 80068	Op. ampl.	TAA521/709C	IC1901	1

* The last digit of these 12-digits code numbers is a 0. This 0 means the last version of this item.
In practice you will find code numbers ending with a 1, 2 or 3 (even up to 9).
Items with different version number are generally interchangeable.
When ordering parts always state the 5322 ..... code.

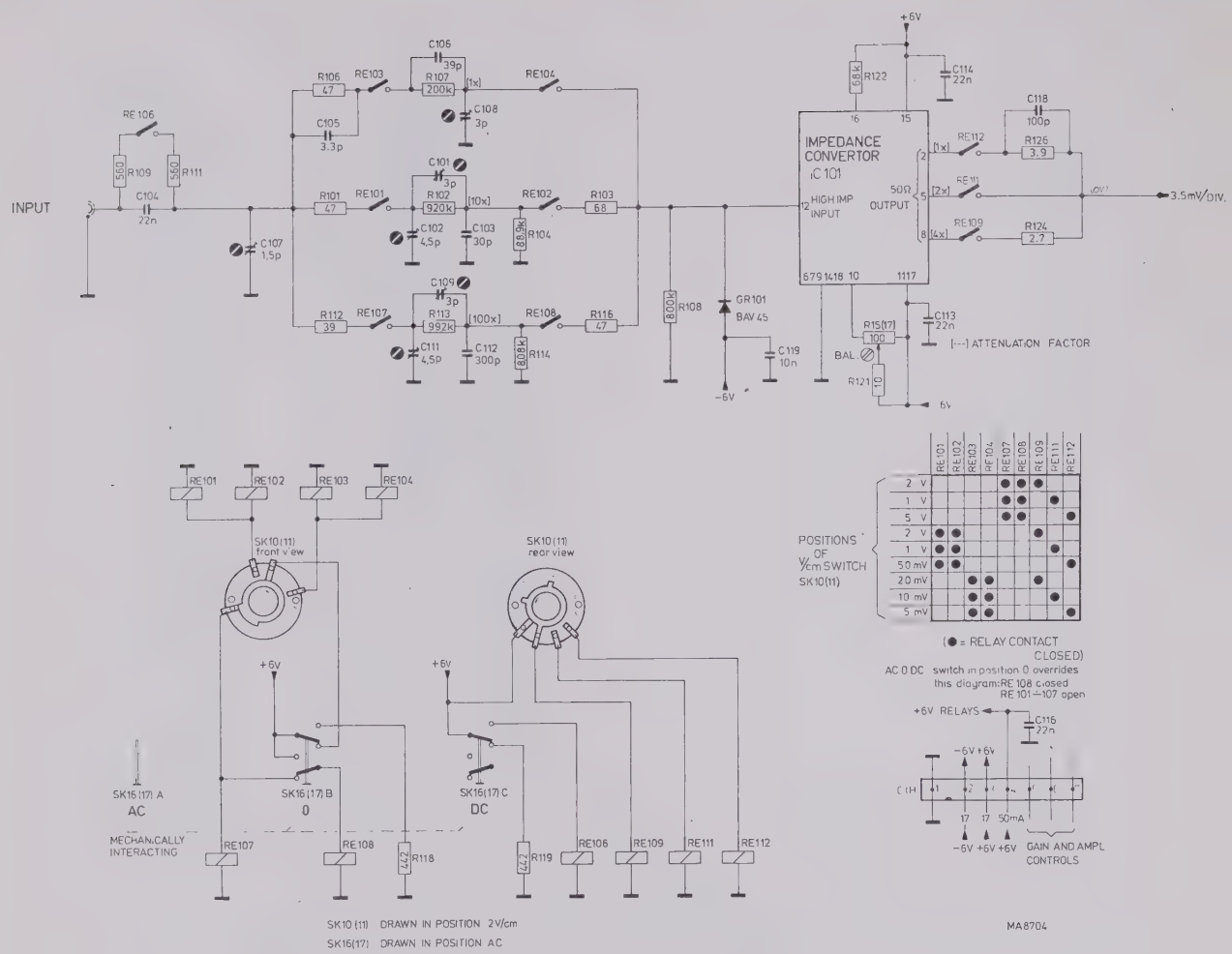


Fig. 3.32. Y Attenuator circuit diagram

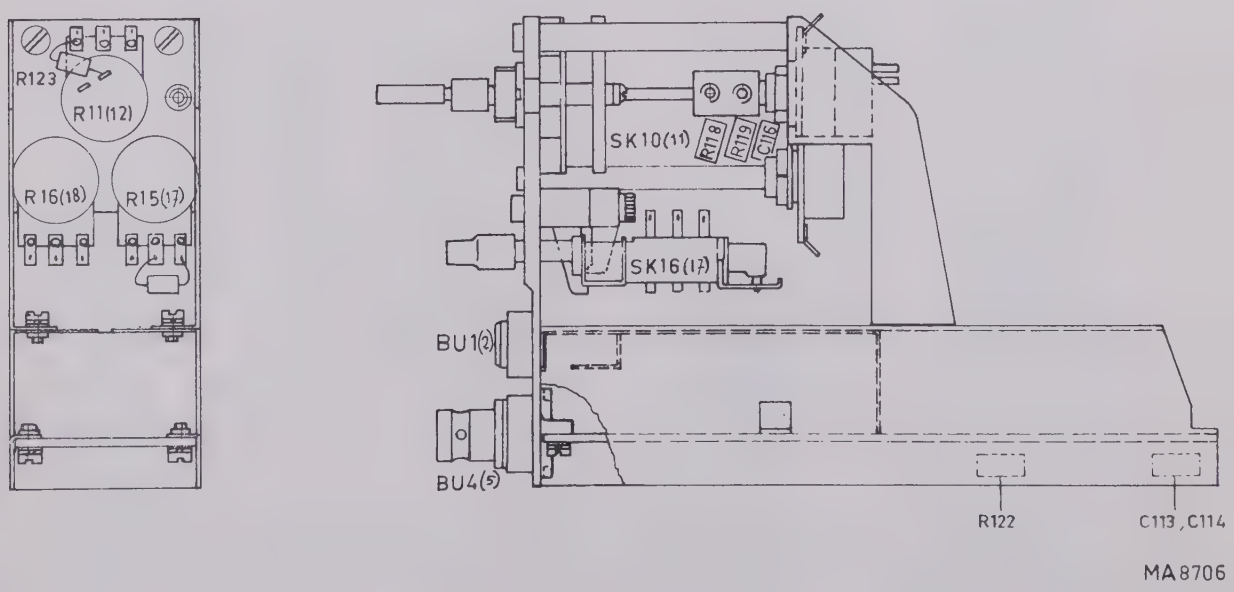
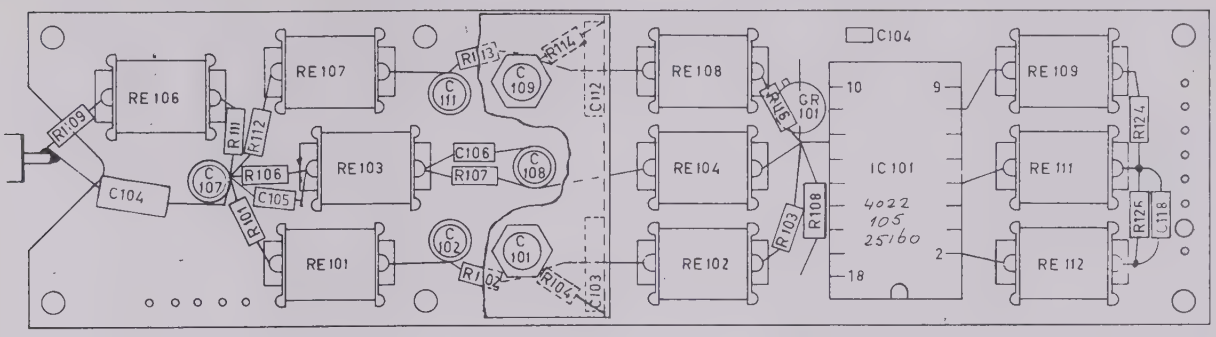


Fig. 3.33. Y Attenuator assembly



MA8705

Fig. 3.34. Y Attenuator circuit board

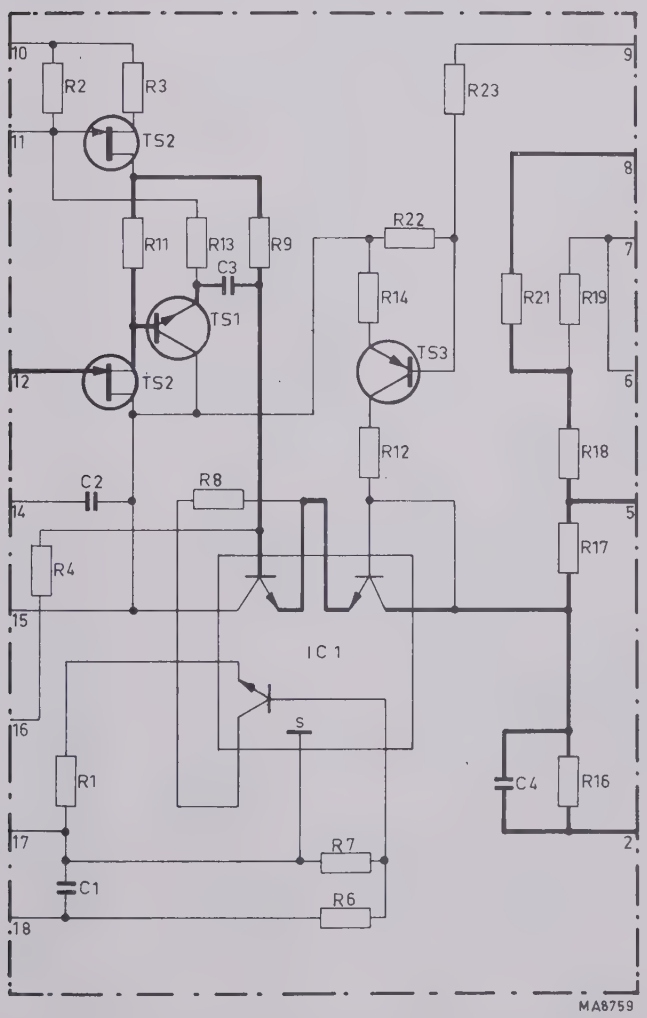


Fig. 3.35. Circuit diagram impedance converter (hybrid circuit)

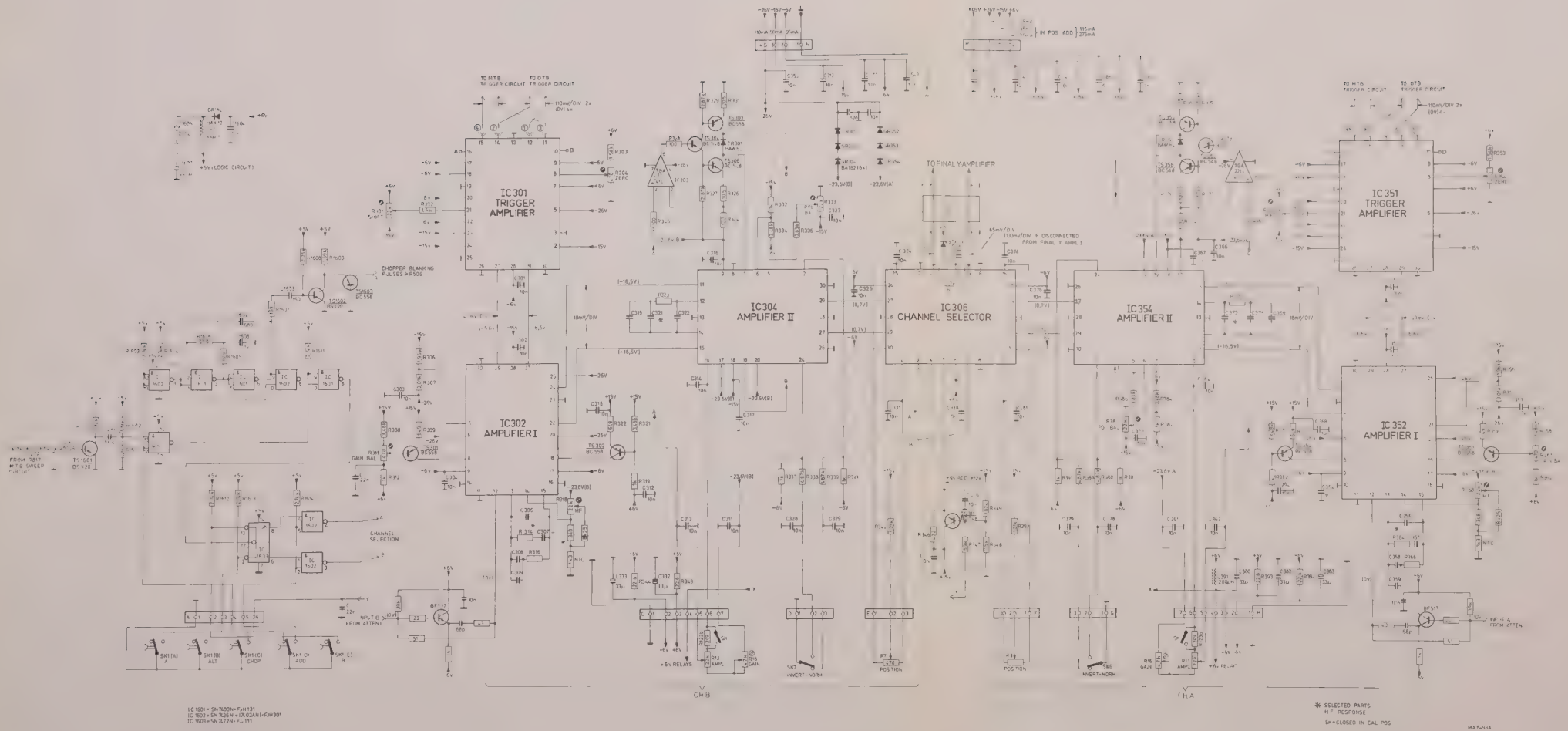


Fig. 3.36. Intermediate Y amplifier circuit diagram

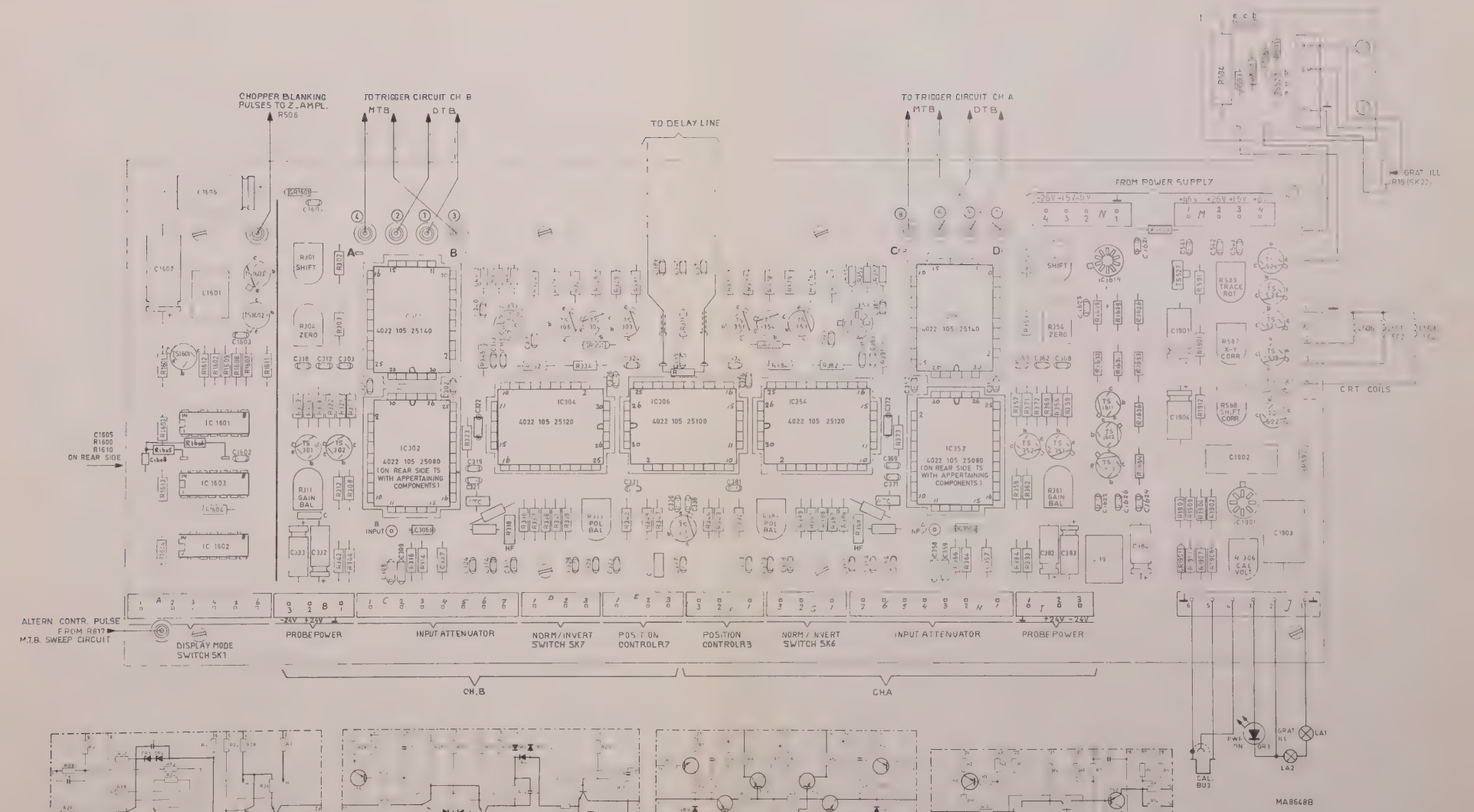


Fig. 3.38. Circuit diagram amplifier I (hybrid circuit)

Fig. 3.39. Circuit diagram amplifier II (hybrid circuit)

Fig. 3.40. Circuit diagram channel selector (hybrid circuit)

Fig. 3.41. Circuit diagram trigger amplifier (hybrid circuit)

Fig. 3.37. Intermediate Y amplifier circuit board

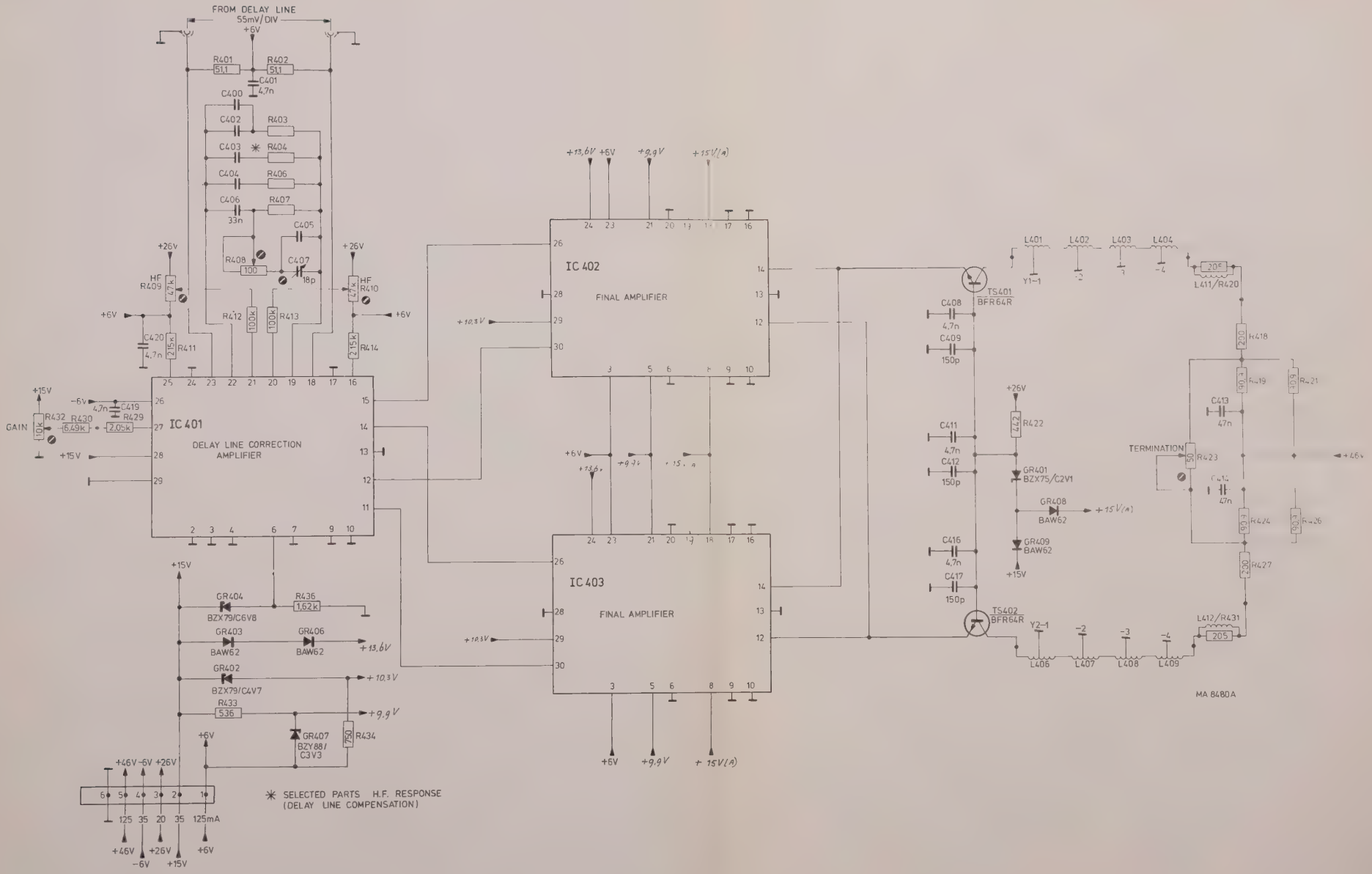


Fig. 3.42. Final Y amplifier circuit diagram

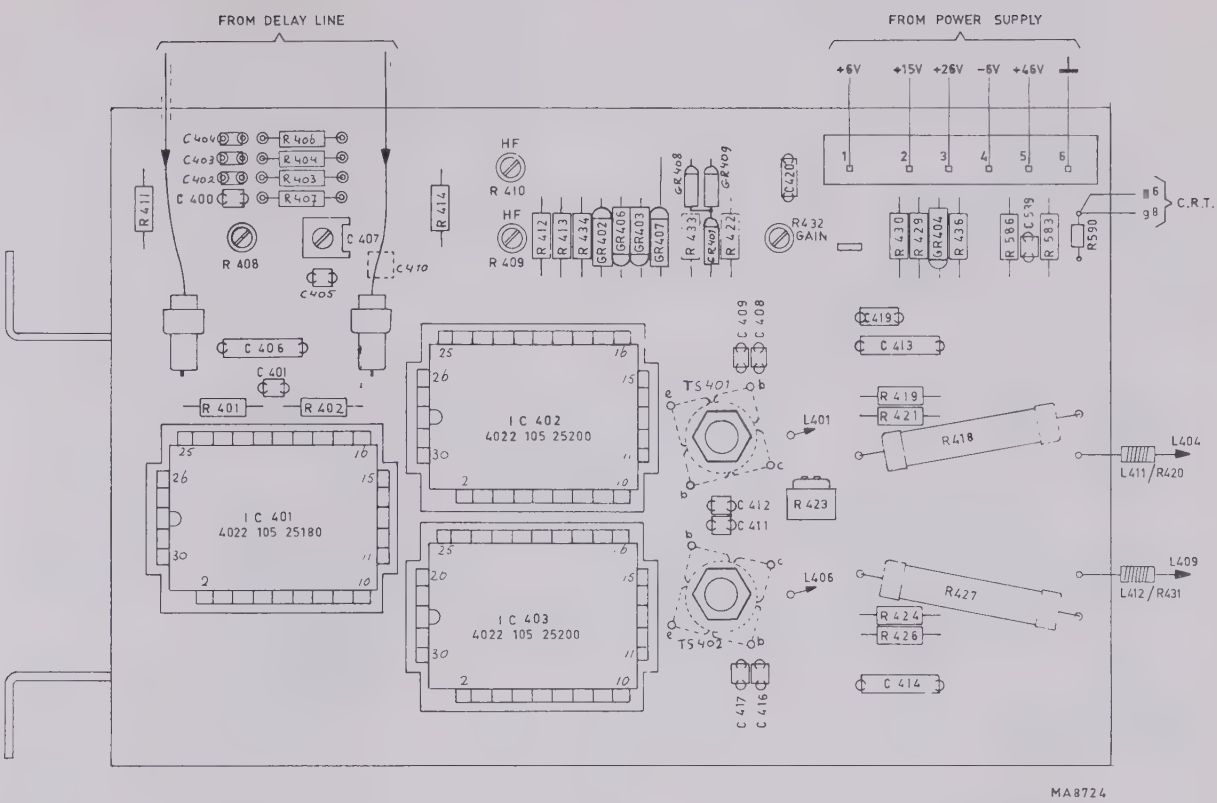


Fig. 3.43. Final Y amplifier circuit board

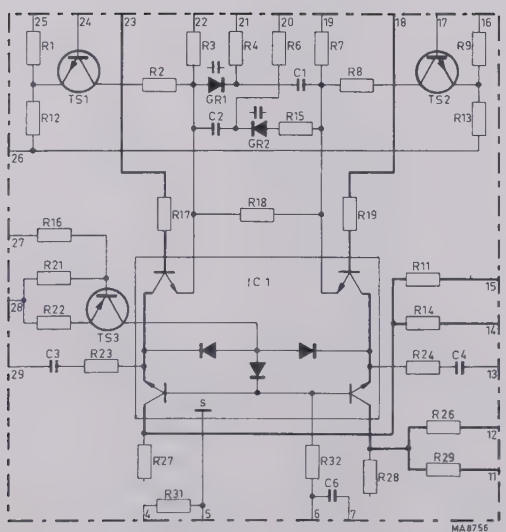


Fig. 3.44. Circuit diagram delay-line correction amplifier (hybrid circuit)

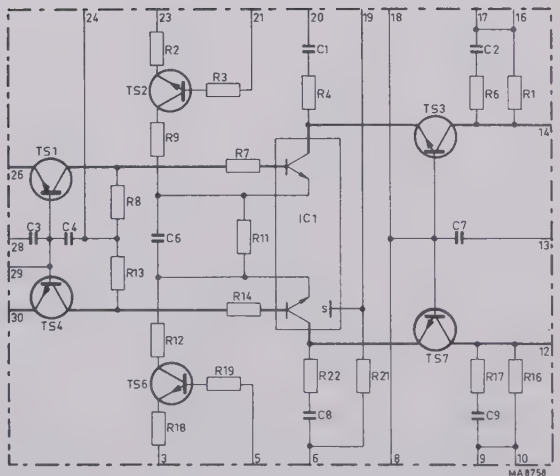


Fig. 3.45. Circuit diagram final amplifier (hybrid circuit)

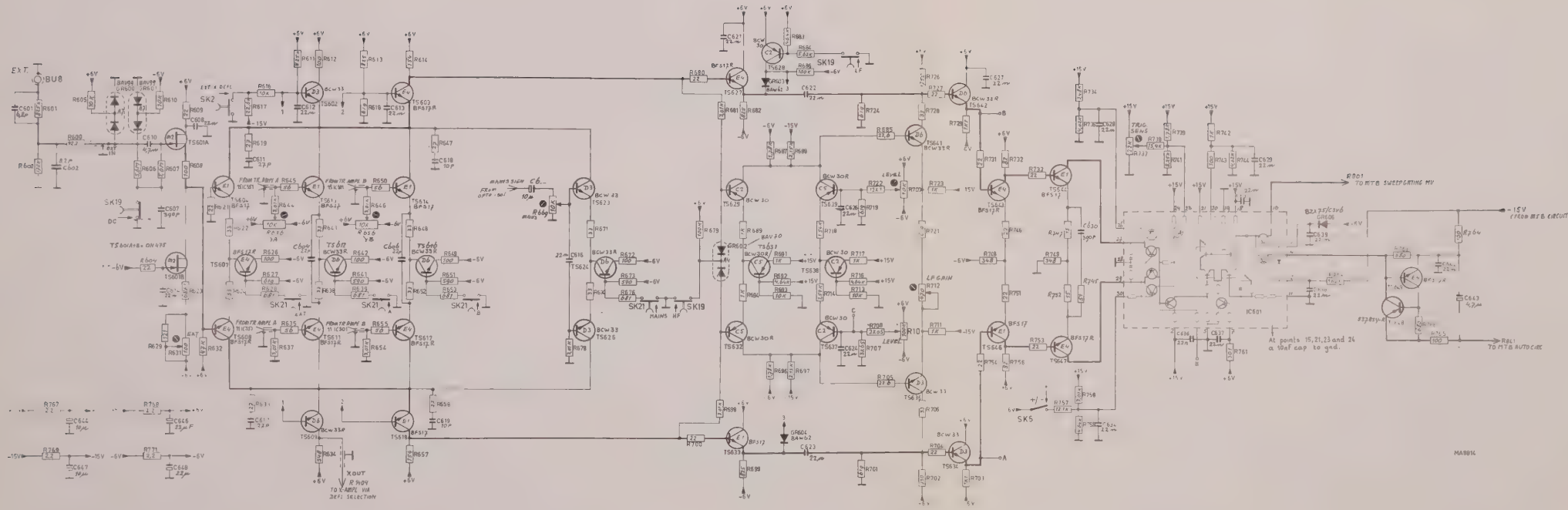


Fig. 3.46. M.T.B. trigger circuit diagram

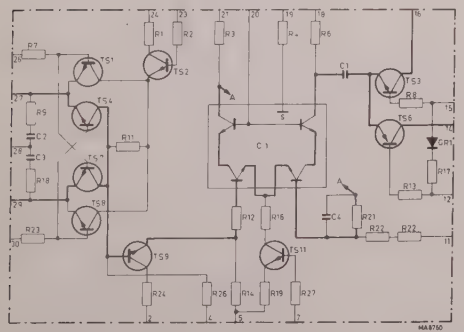


Fig. 3.47. Circuit diagram trigger-pulse shaper (hybrid circuit)

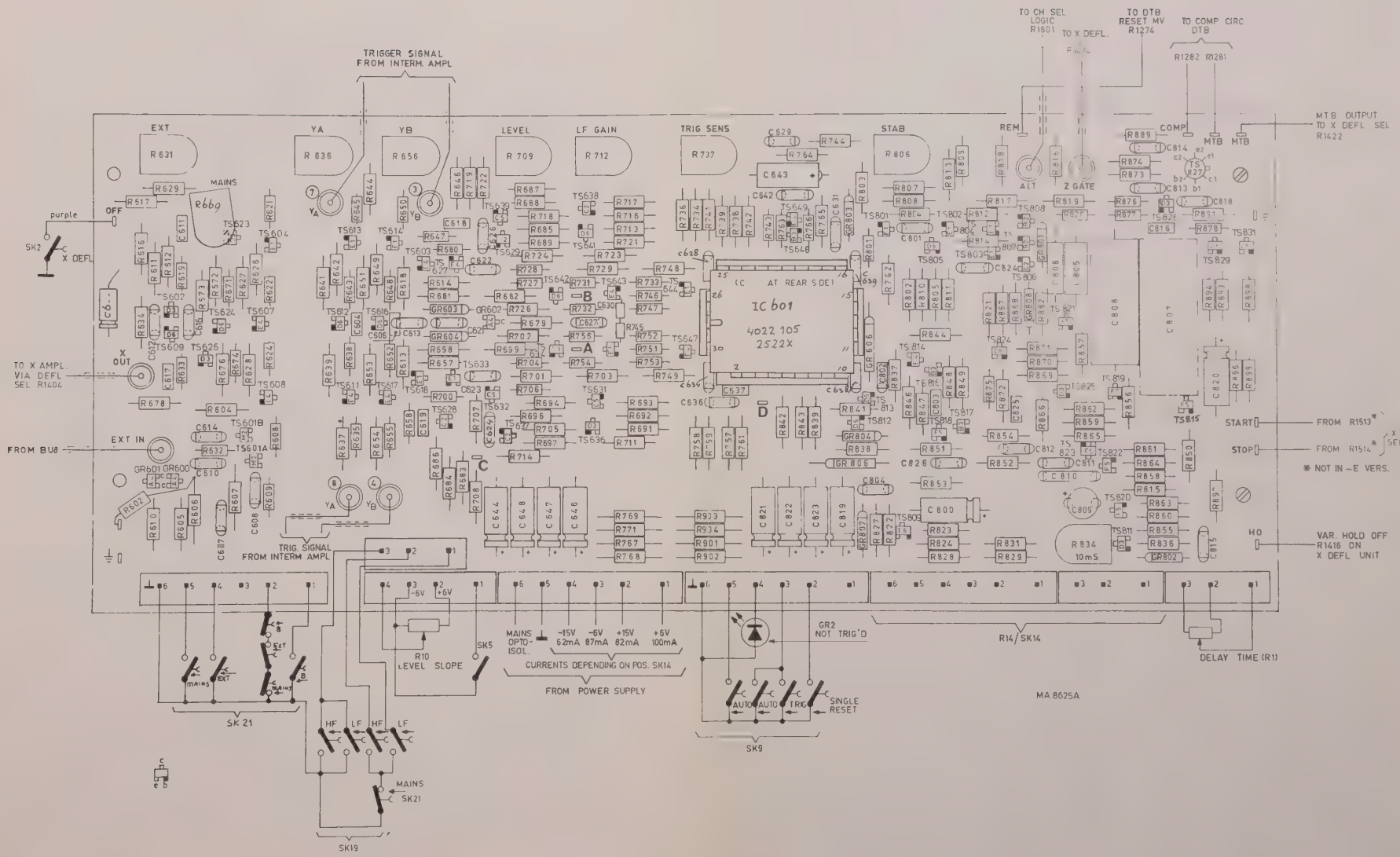


Fig. 3.48. M.T.B. circuit board

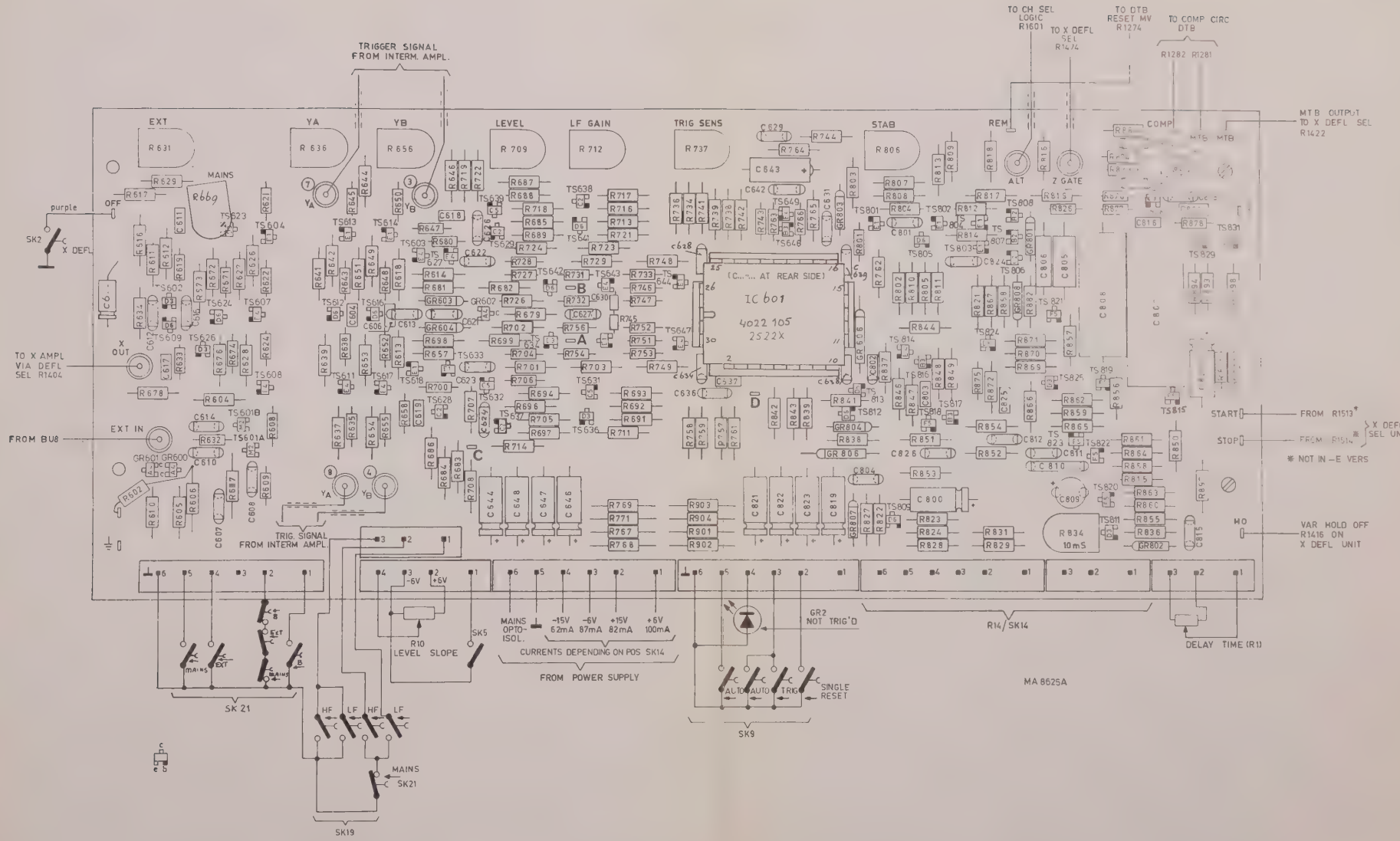


Fig. 3.48. M.T.B. circuit board

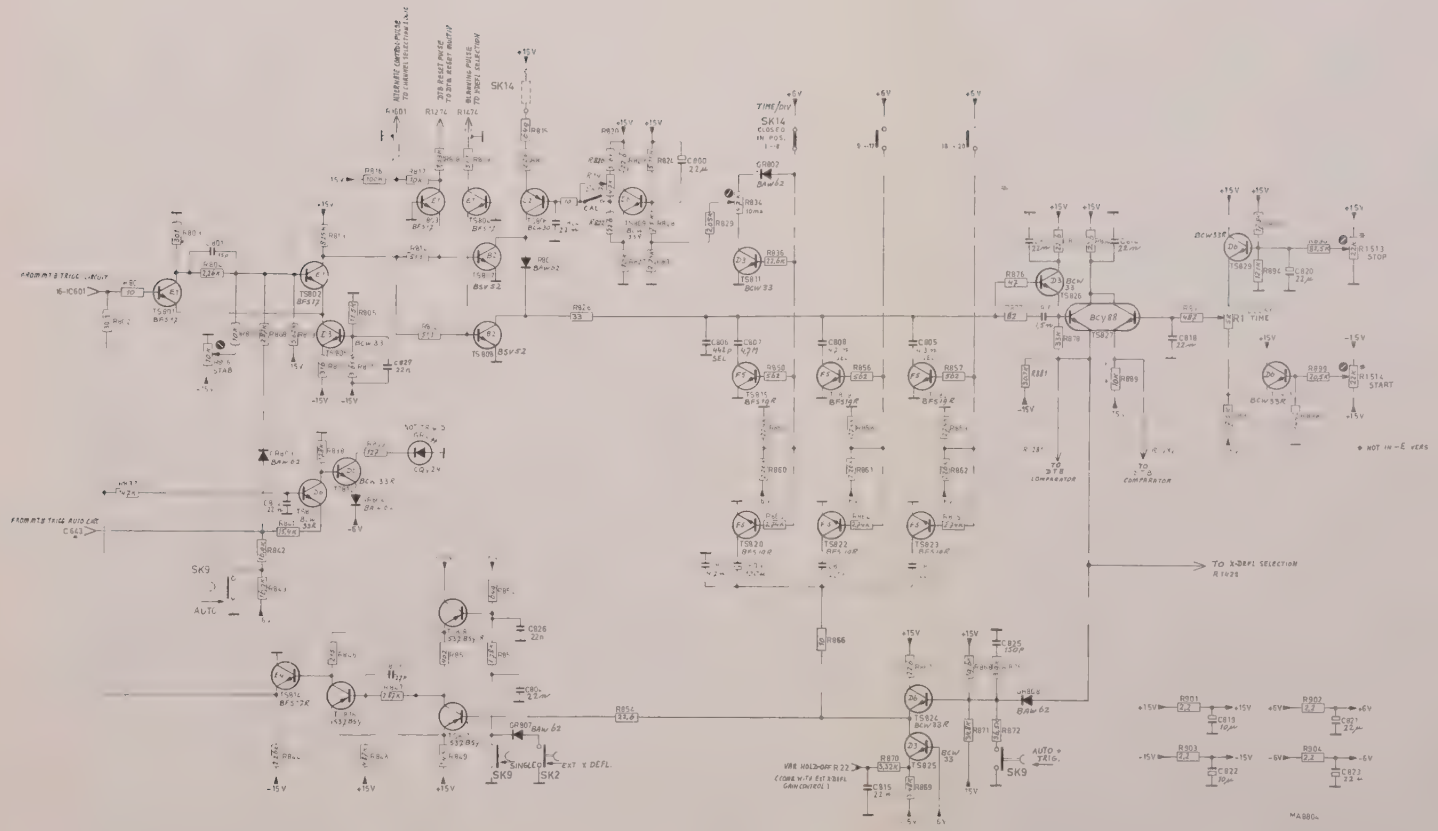


Fig. 3.49. M.T.B. sweep circuit diagram

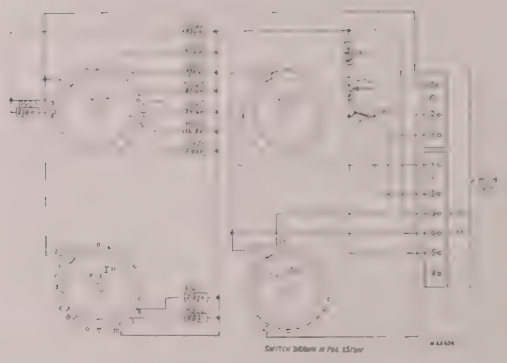


Fig. 3.50. M.T.B. TIME/DIV switch

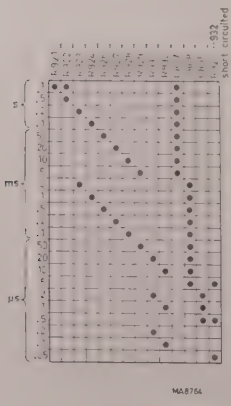


Fig. 3.51. Table of TIME/DIV switch positions

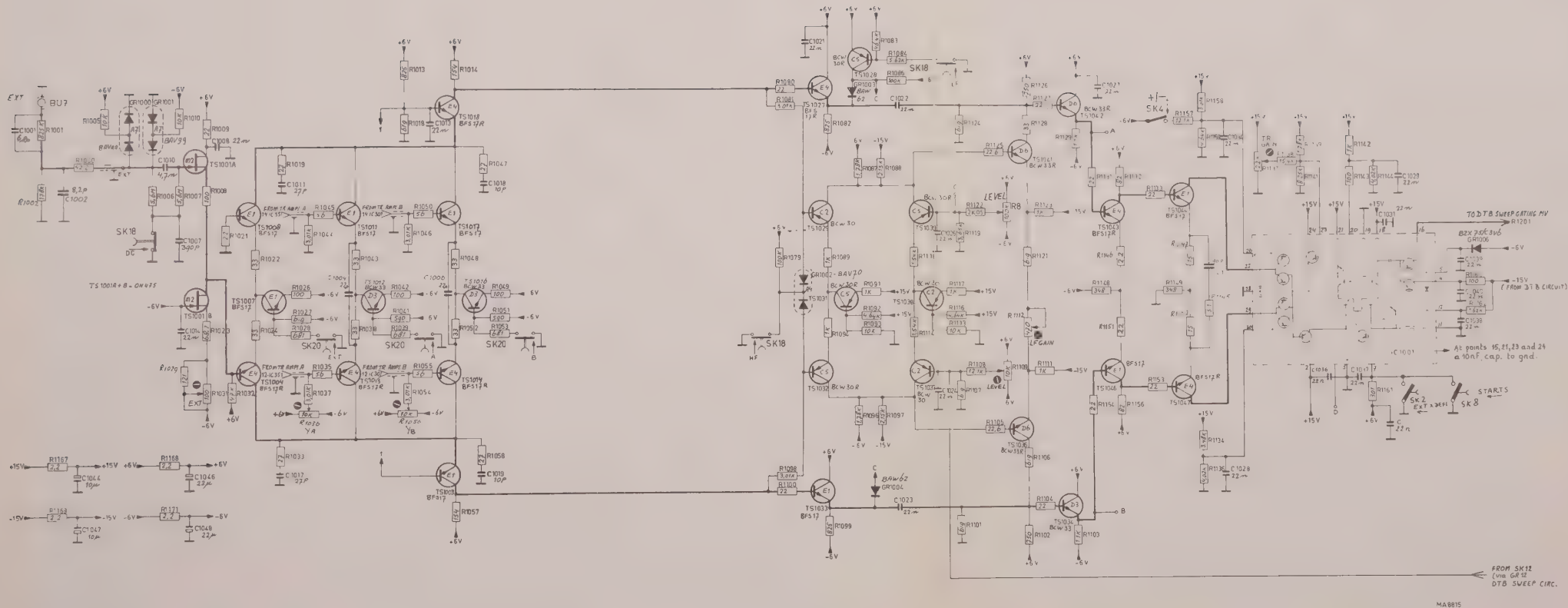


Fig. 3.52. D.T.B. trigger circuit diagram

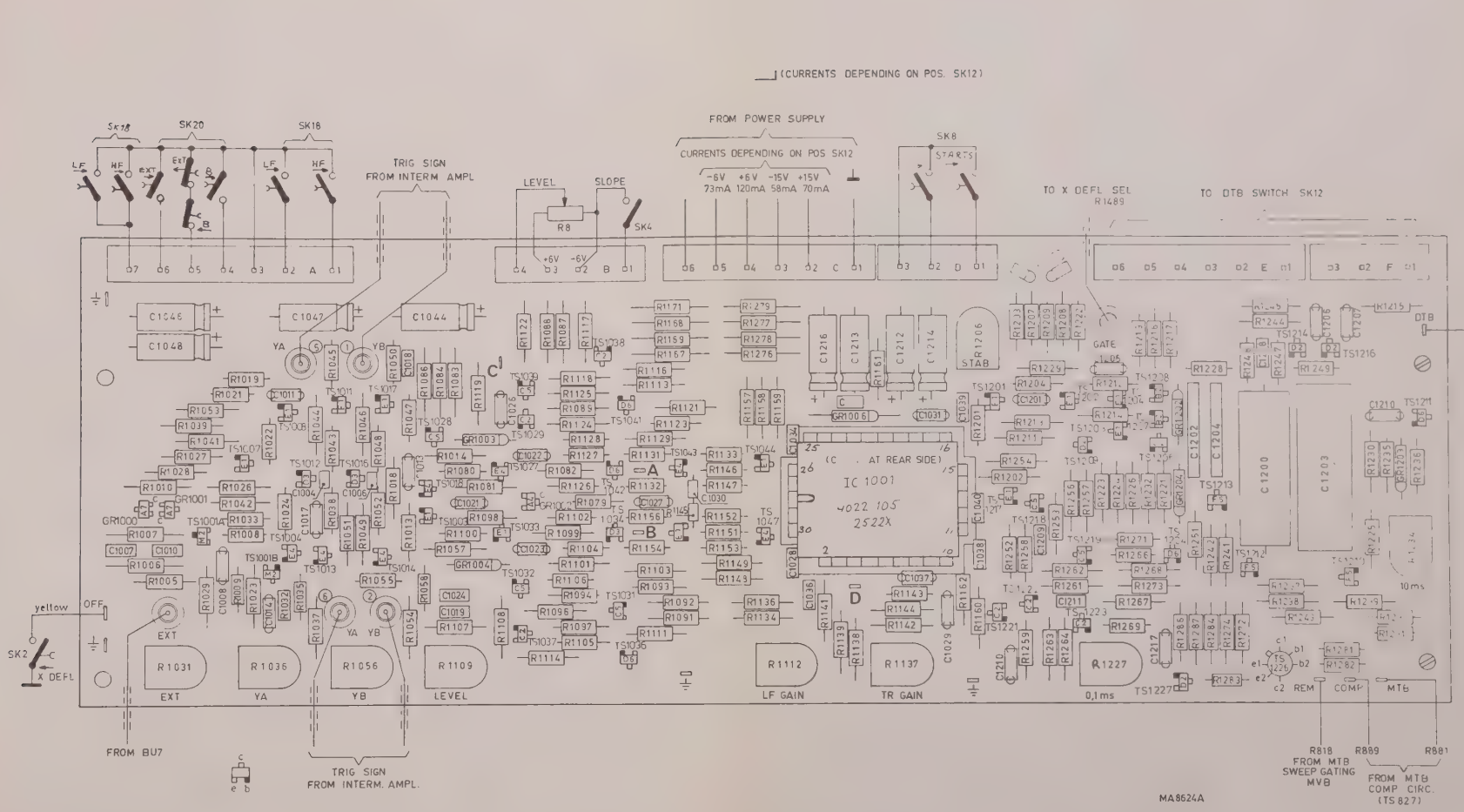


Fig. 3.53. D.T.B. circuit board

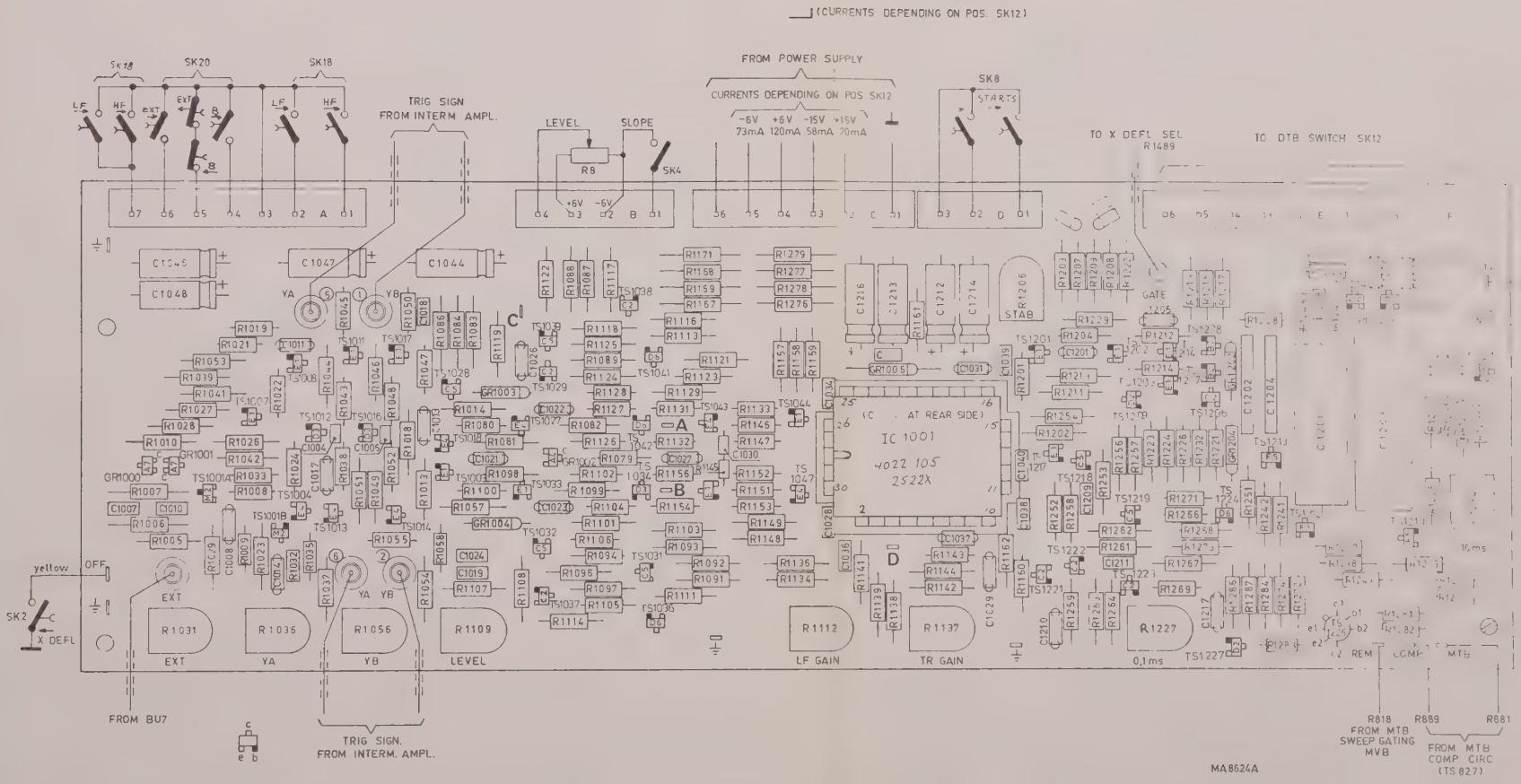


Fig. 3.53. D.T.B. circuit board

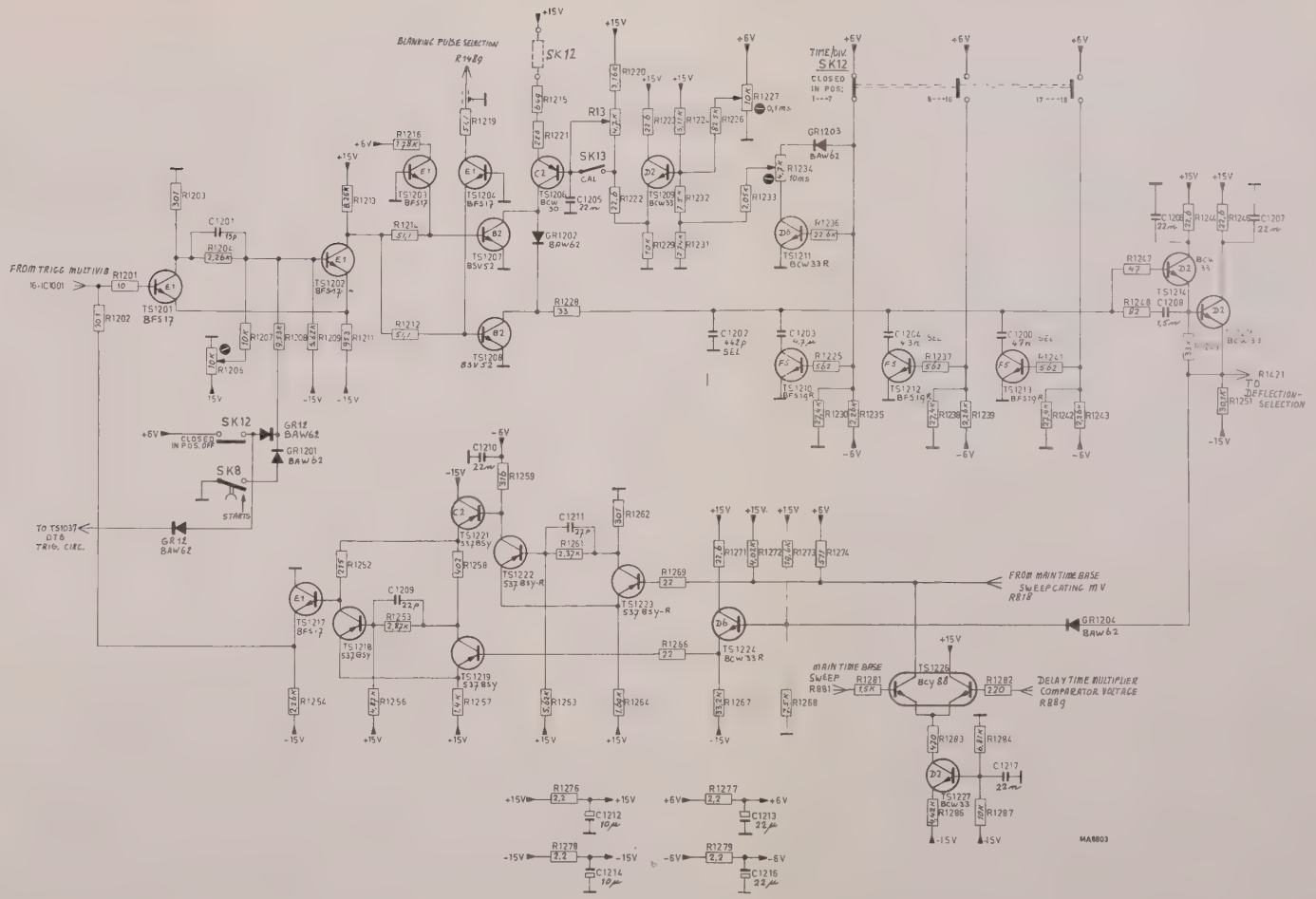


Fig. 3.54. D.T.B. sweep circuit diagram

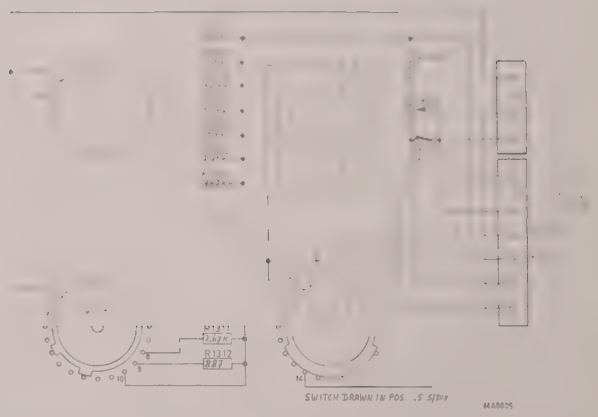


Fig. 3.55. D.T.B. TIME/DIV switch

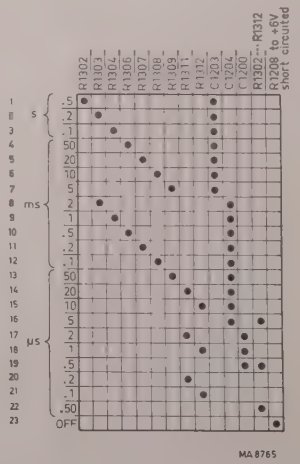


Fig. 3.56. Table of TIME/DIV switch positions

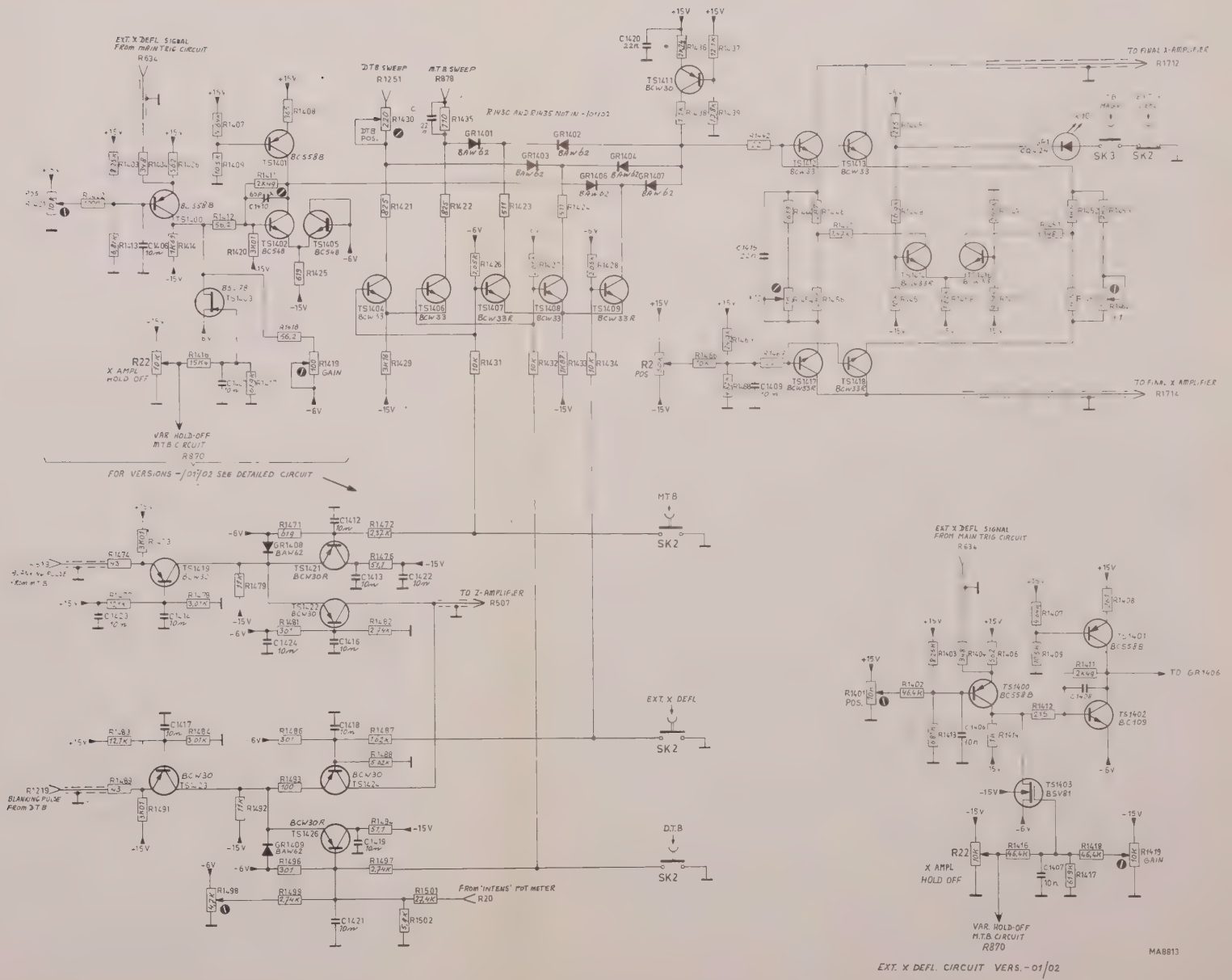


Fig. 3.57. X Deflection selector circuit diagram

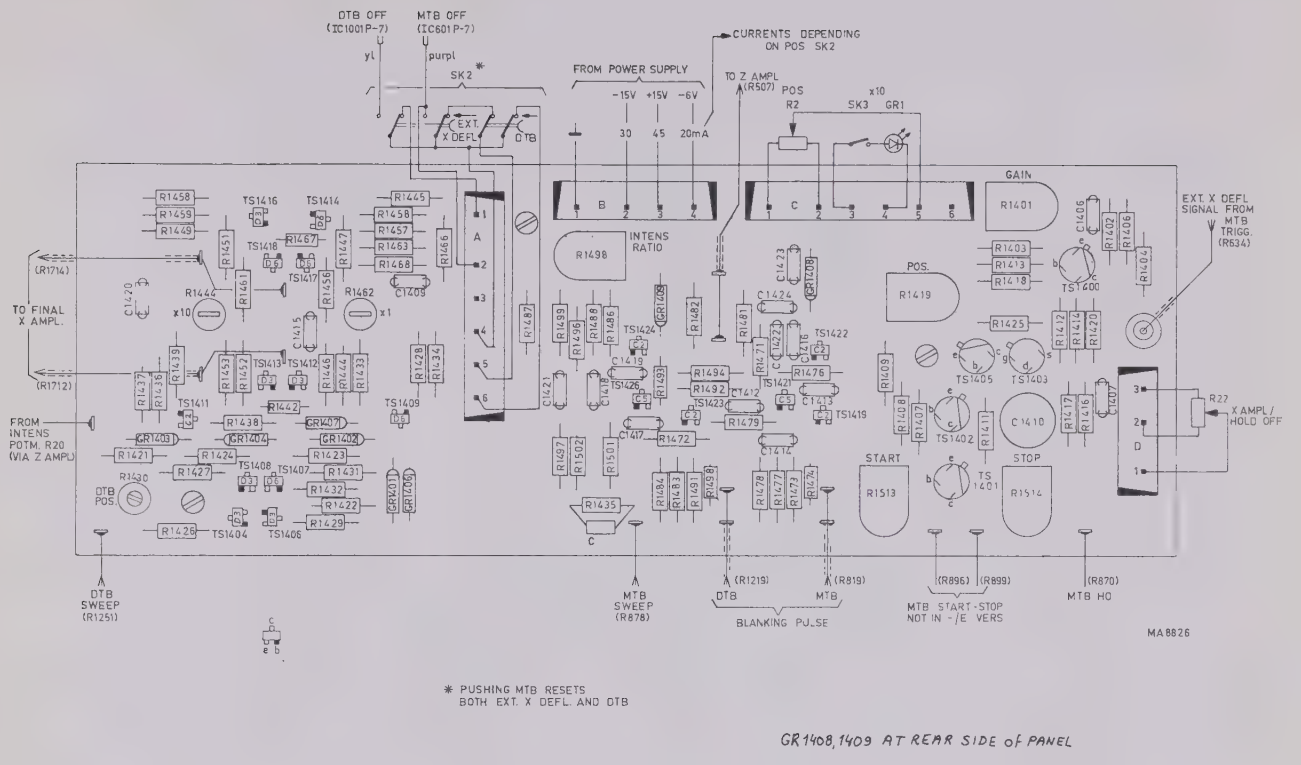


Fig. 3.58. X Deflection selector board PM 3260/03

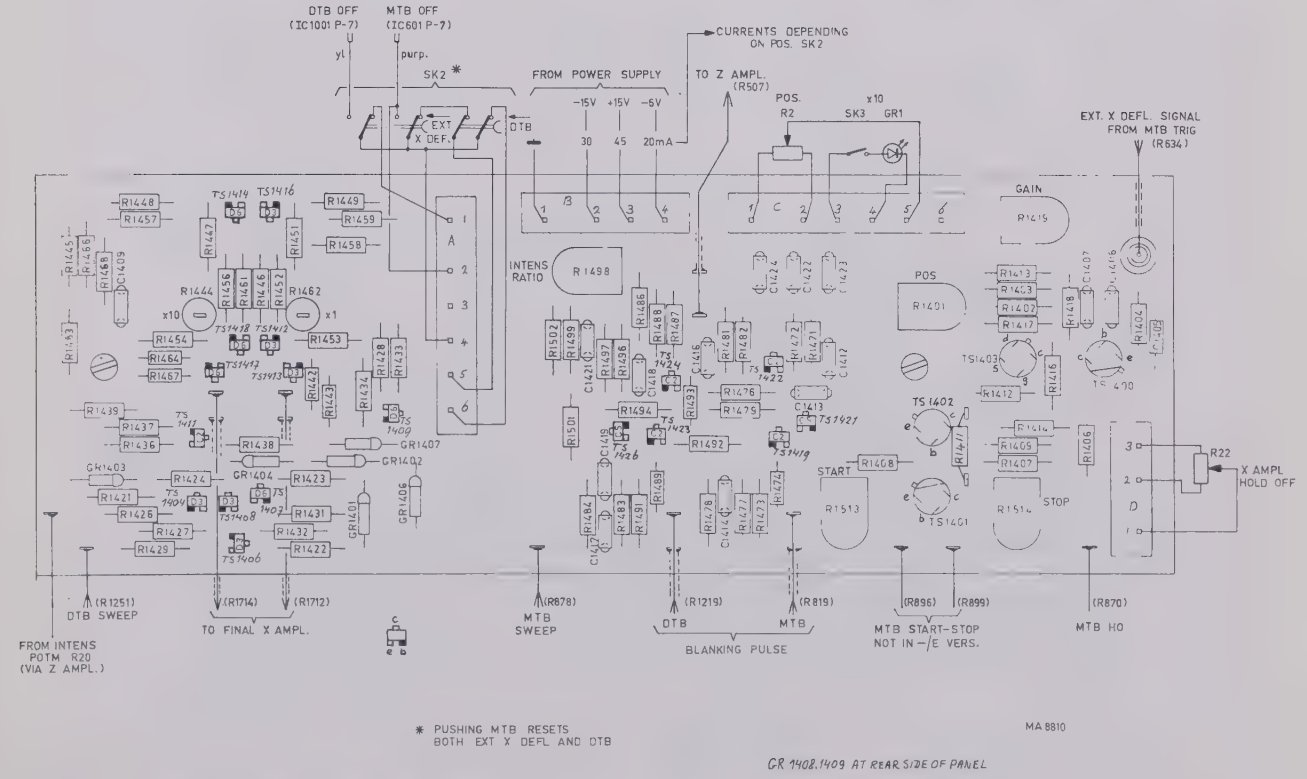


Fig. 3.59. X Deflection selector board PM 3260/02

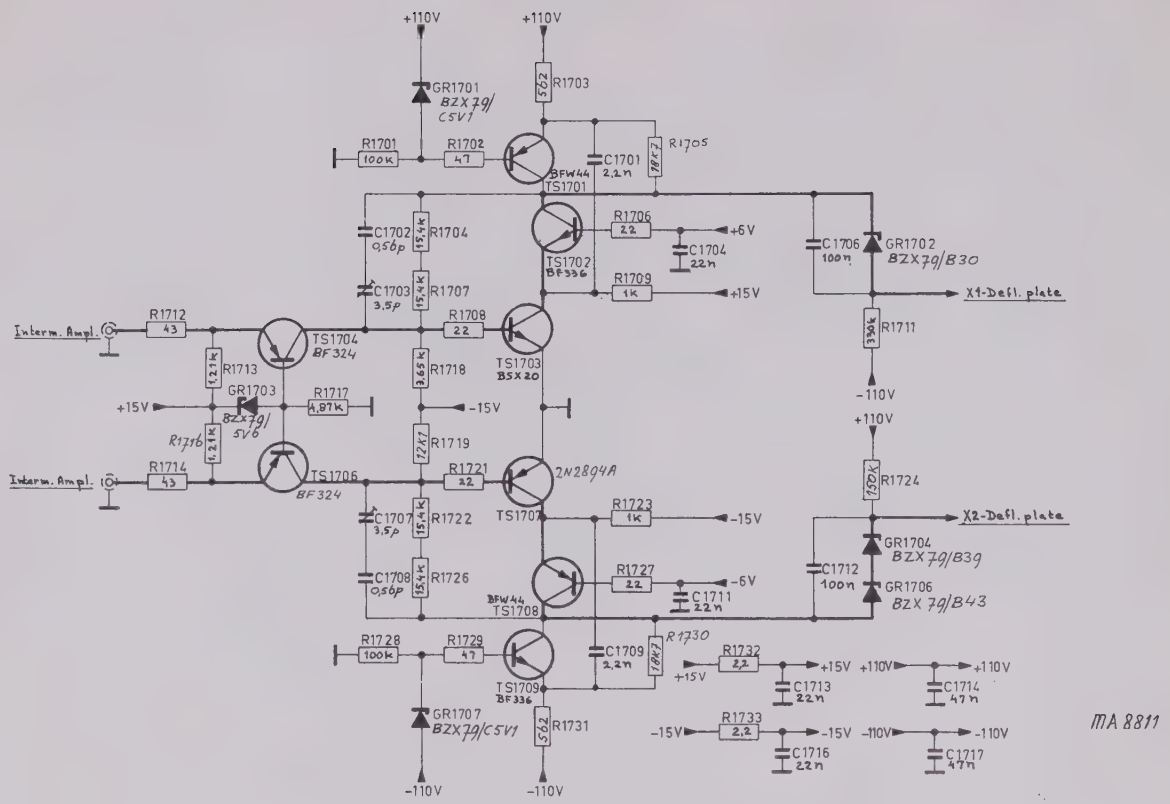


Fig. 3.60. Final X amplifier circuit diagram

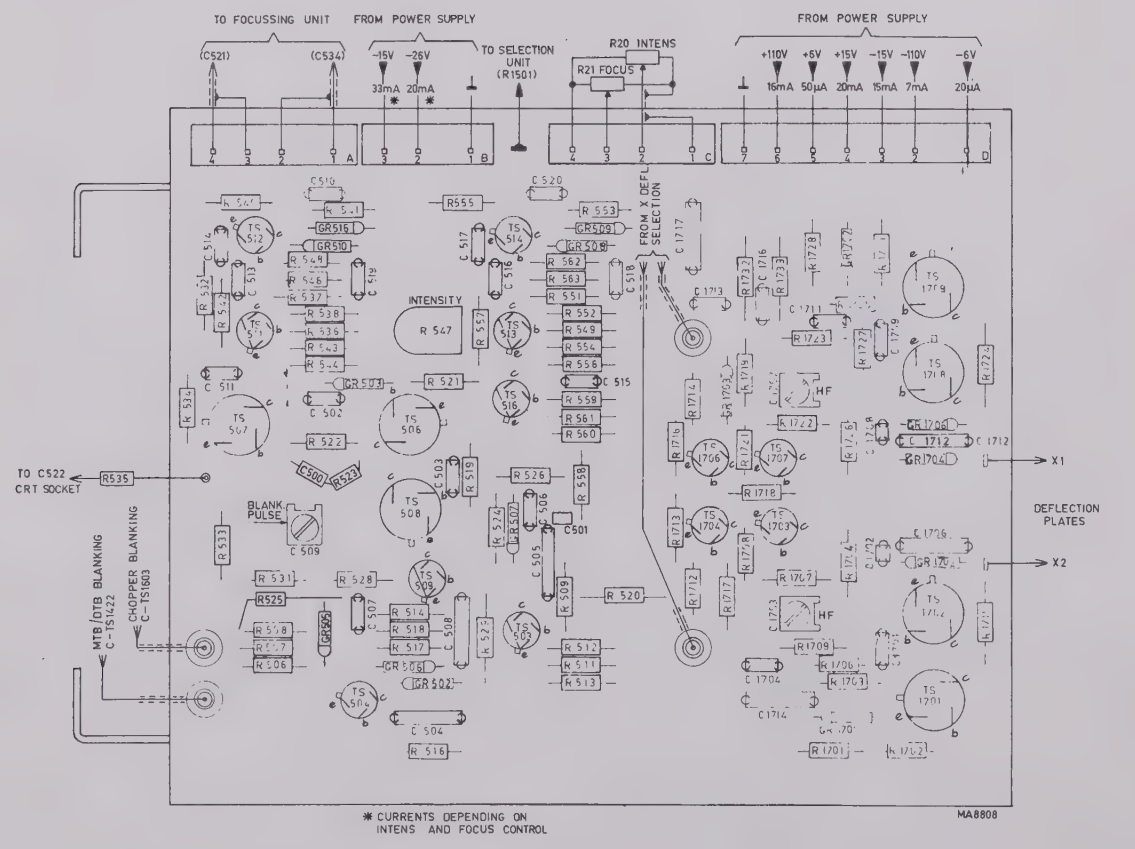


Fig. 3.61. Final X and Z amplifier board

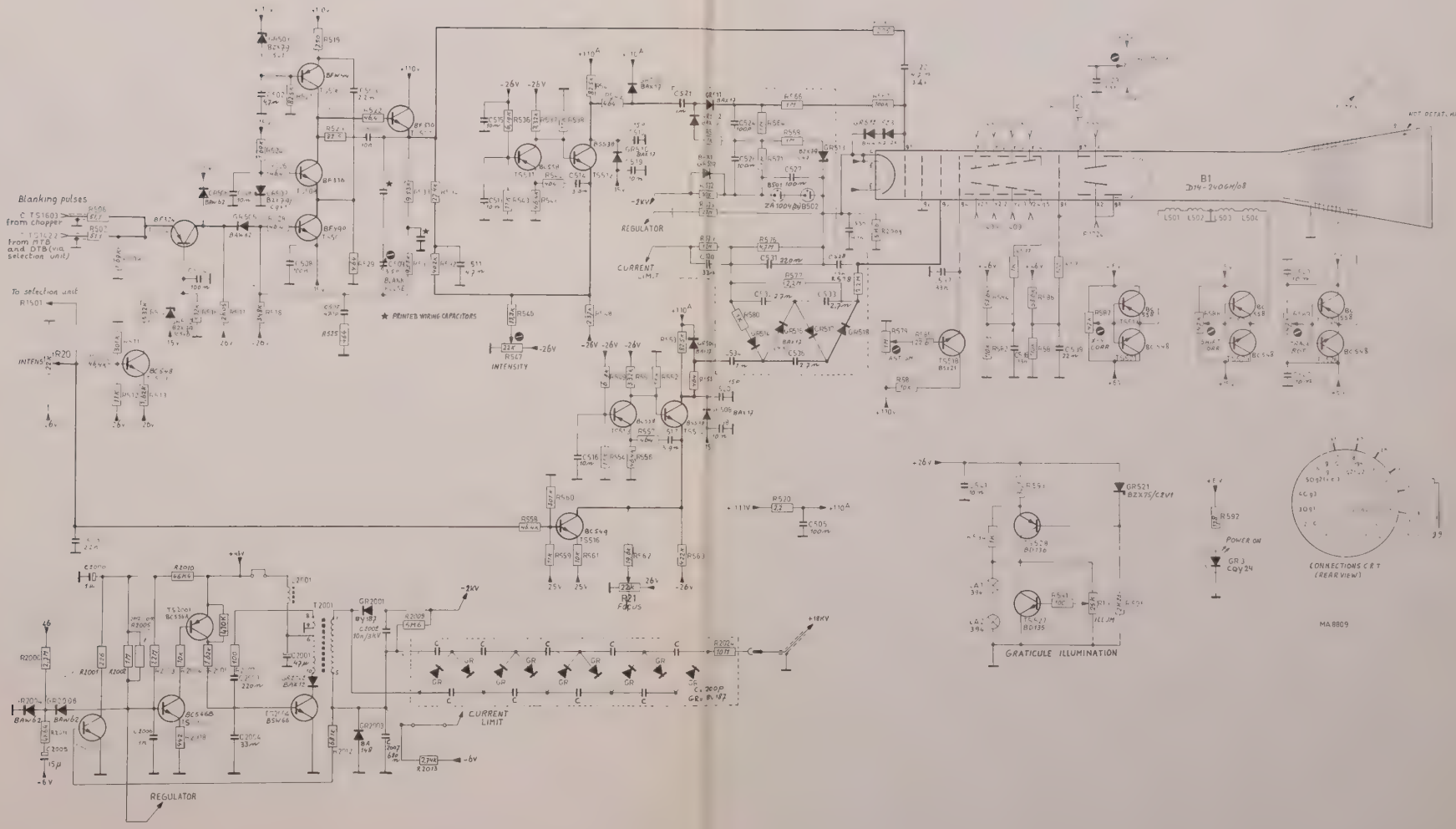


Fig. 3.62. Z Amplifier, 2 kV and c.r.t. circuit diagram

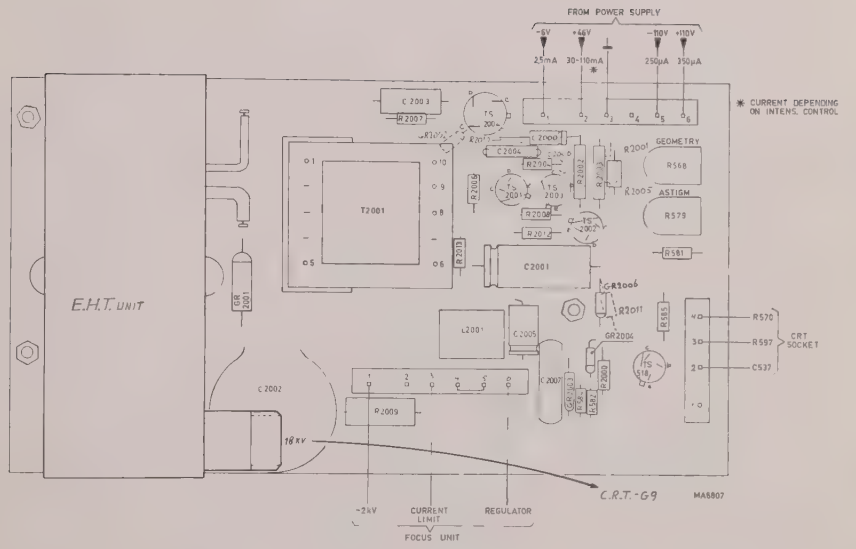


Fig. 3.63. 2 kV Unit

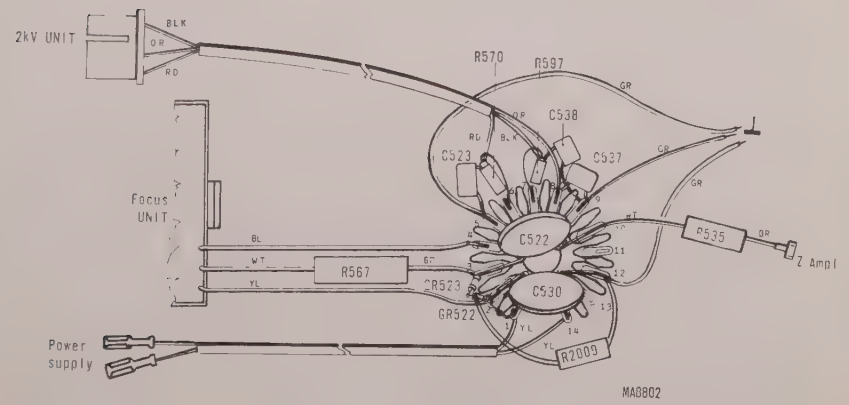


Fig. 3.64. C.r.t. socket assembly

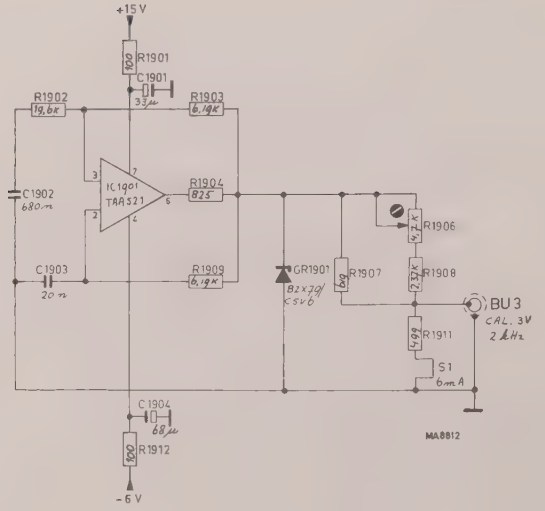


Fig. 3.65. Calibration circuit diagram

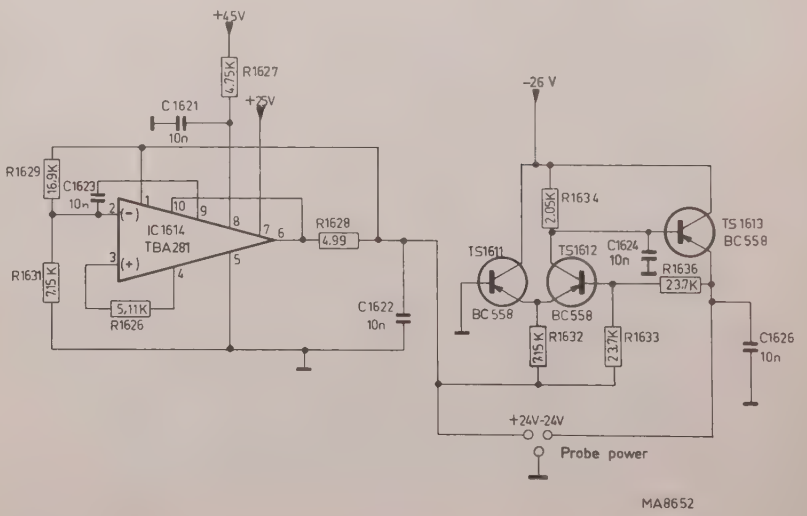


Fig. 3.66. Probe power circuit diagram

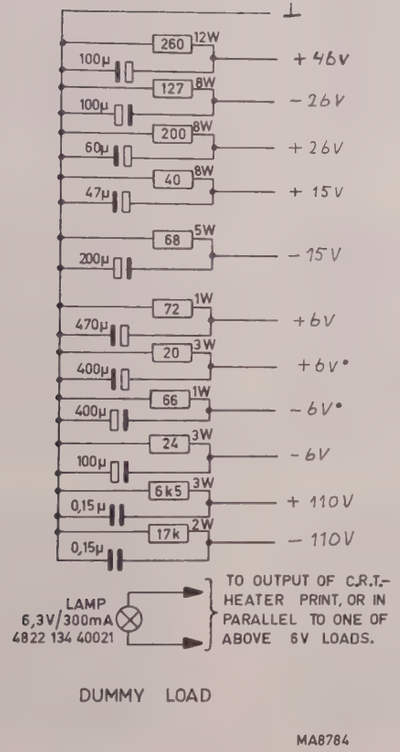


Fig. 3.67. Dummy load for power supply

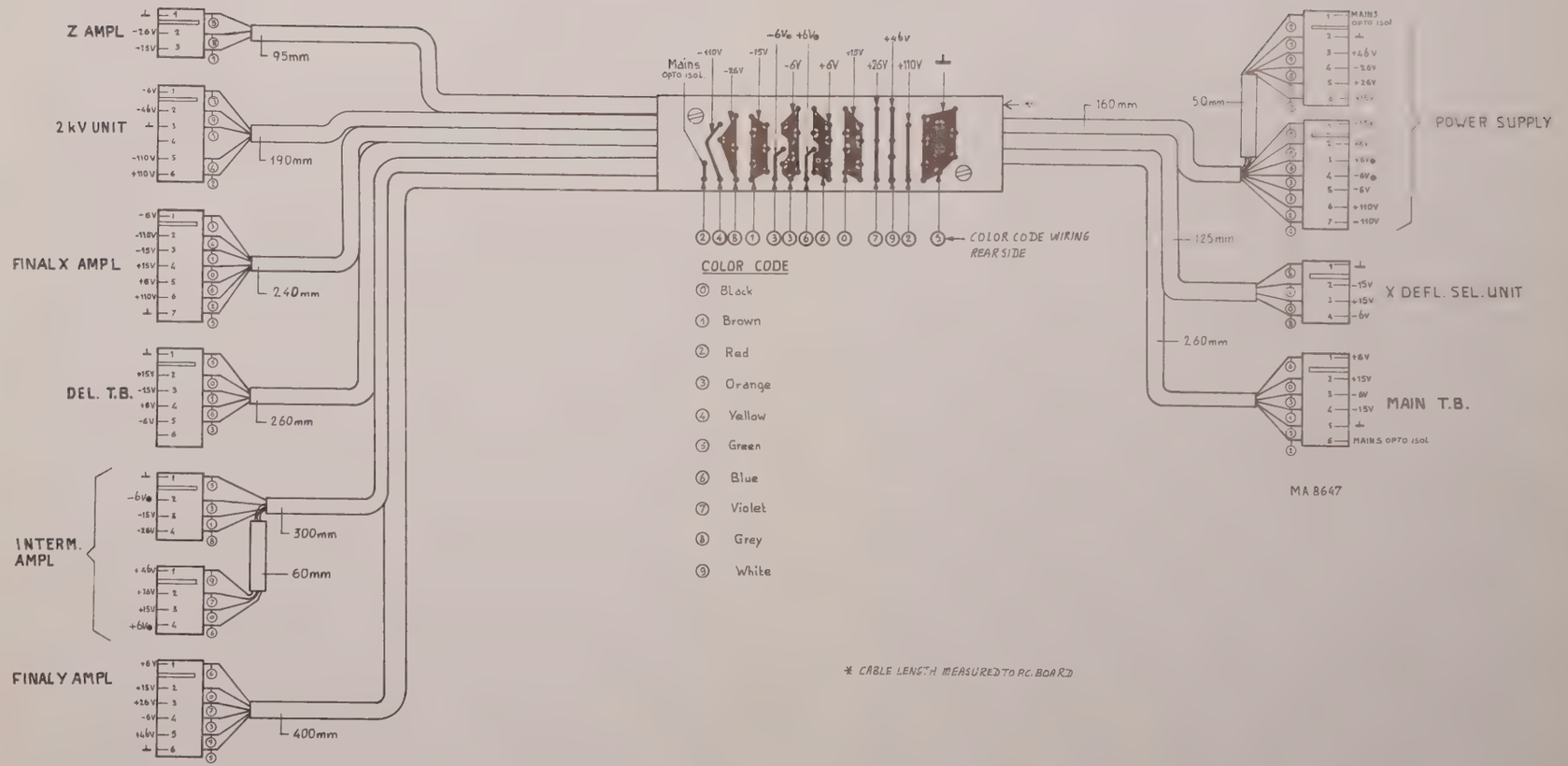


Fig. 3.68. Power distribution unit

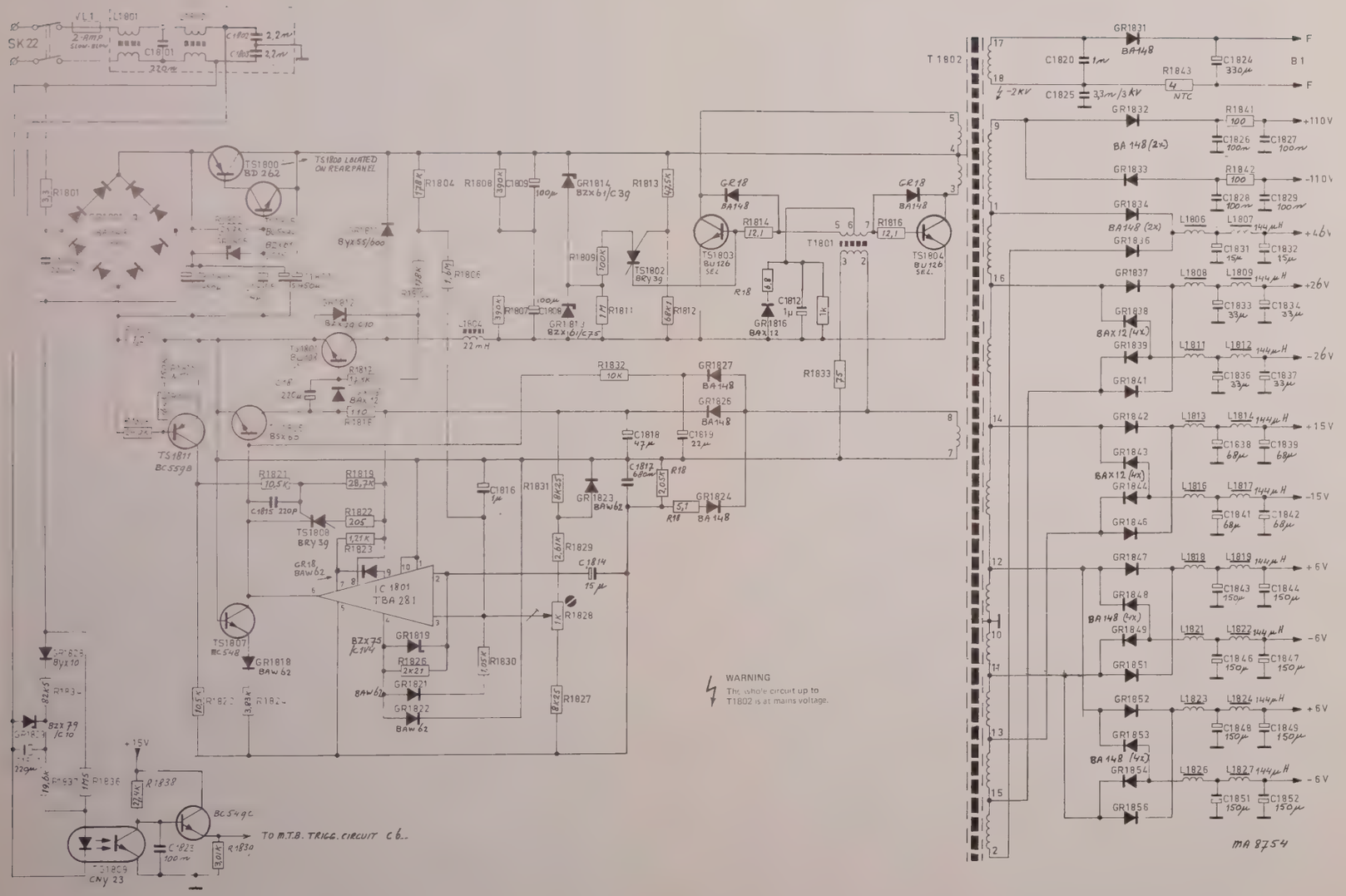
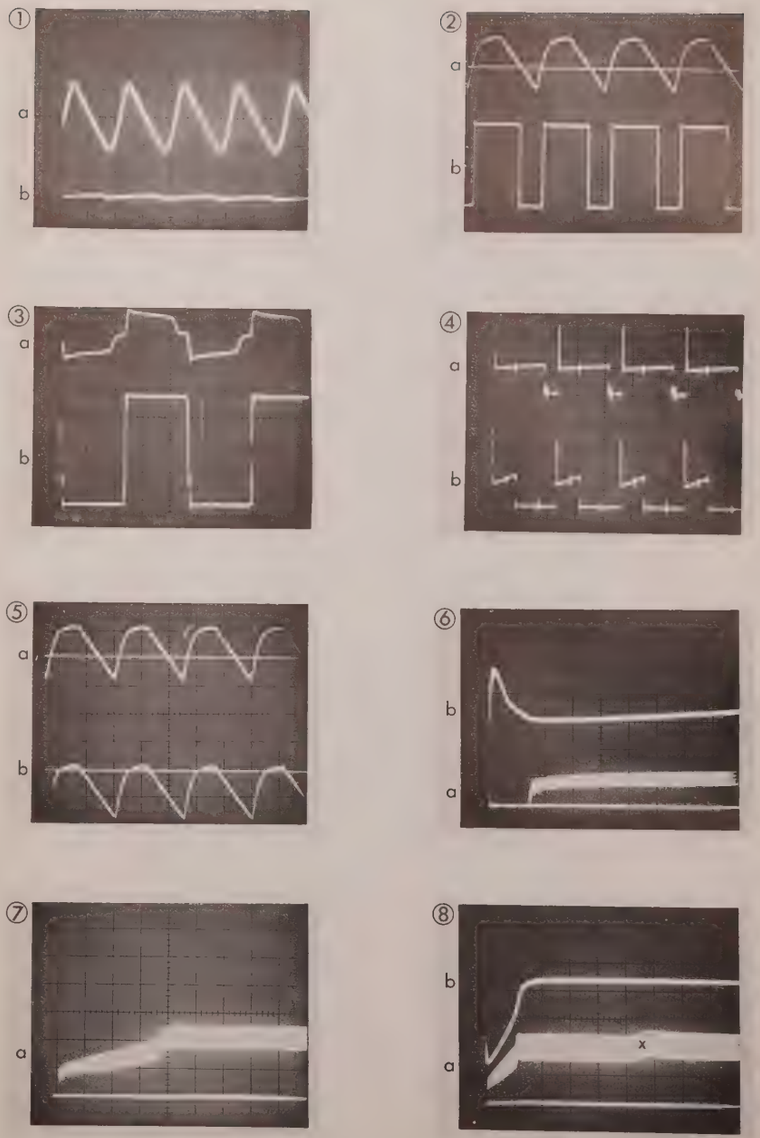


Fig. 3.69. Power supply circuit diagram



WAVEFORMS IN THE POWER SUPPLY

(Photographs taken from storage oscilloscope PM 3251)

1. **Mains ripple eliminator (TS1800)**

   a. A.C. Voltage on the emitter of TS1800
   b. A.C. Voltage on the collector of TS1800
   Both voltages are measured with respect to the negative pole of electrolytic capacitor C1806.
   Mains voltage 220 V
   PM 3251 settings: 5 V/DIV; 5 ms/DIV; external triggering from the mains.

2. **Regulator input voltage versus voltage across switching transistor TS1801**

   a. Voltage on p3 with respect to p2 of IC1801
   b. Collector-emitter voltage of TS1801; lower line is 0 V
   Mains voltage 220 V
   PM 3251 settings: 200 mV/DIV for a; 100 V/DIV for b;
   20 ms/DIV; external triggering from p5T1802.

3. **Chopper**

   a. Voltage between p2 and p3 of transformer T1801
   b. Voltage between p7 and p8 of transformer T1802
   Mains voltage 220 V
   PM 3251 settings: 5 V/DIV; 10 µs/DIV; external triggering from p5T1802.

4. **Switching transistor TS1801**

   Current flowing through R1802

   a. Mains voltage 110 V
   b. Mains voltage 220 V
   PM 3251 settings: 0.5 V/DIV (= 0.4 A/DIV); 20 µs/DIV; external triggering from p5T1802.

5. **Regulator input voltage at 220 V and 110 V mains voltage**

   Voltage on p3 with respect to p2 of IC1801
   a. at 220 V
   b. at 110 V
   PM 3251 settings: 200 mV/DIV; 20 ms/DIV; external triggering from p5T1802.

6. **Switching-on period**

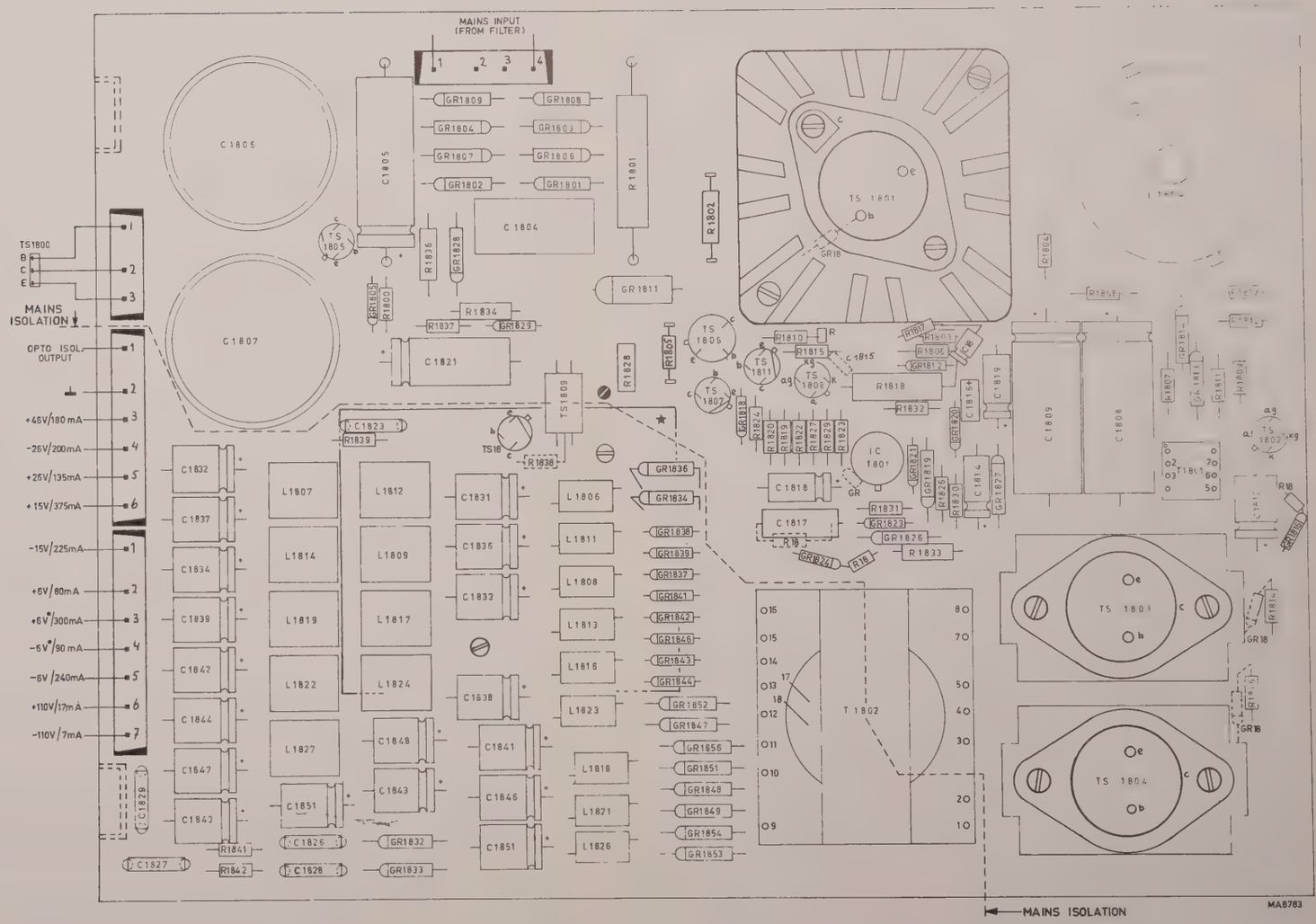
   a. Voltage across R1802
   b. Voltage on p8 of IC1801 with respect to p1 and p10
   Lower line is 0 V
   Mains voltage 220 V
   PM 3251 settings: 200 mV/DIV for a; 1 V/DIV for b; external triggering from p5T1802; single shot.

7. **Switching-on period**

   As photograph 6a, but with a PM 3251 setting of 50 ms/DIV.

8. **Switching-on period**

   As photographs 6a and 6b, but at a PM 3251 setting of 200 ms/DIV.
   At point X the 2-kV-generator switches on.



★ C.R.T. HEATER SUPPLY PRINT
CONTAINING: C 1820.1824.1825, GR1831, R 1843

Fig. 3.70. Power supply board

QUALITY REPORTING

CODING SYSTEM FOR FAILURE DESCRIPTION

The following information is meant for Philips service workshops only and serves as a guide for exact reporting of service repairs and maintenance routines on the workshop charts.
For full details reference is made to Information G1 (Introduction) and Information Cd 689 (Specific information for Test and Measuring Instruments).

LOCATION

□□□

Unit number
e.g. 000A or 0001 (for unit A or 1; **not 00UA or 00U1)**

or: Type number of an accessory (only if delivered with the equipment)
e.g. 9051 or 9532 (for PM 9051 or PM 9532)

or: Unknown/Not applicable
0000

COMPONENT/SEQUENCE NUMBER

□□□□□

Enter the identification **as used in the circuit diagram,** e.g.:

GR1003	Diode GR1003
TS0023	Transistor TS23
IC0101	Integrated circuit IC101
R0....	Resistor, potentiometer
C0....	Capacitor, variable capacitor
B0....	Tube, valve
LA....	Lamp
VL....	Fuse
SK....	Switch
BU....	Connector, socket, terminal
T0....	Transformer
L0....	Coil
X0....	Crystal
CB....	Circuit block
RE....	Relay
BA....	Battery
TR....	Chopper

CATEGORY

□

0 Unknown, not applicable (fault not present, intermittent or disappeared)
1 Software error
2 Readjustment
3 Electrical repair (wiring, solder joint, etc.)
4 Mechanical repair (polishing, filing, remachining, etc.)
5 Replacement
6 Cleaning and/or lubrication
7 Operator error
8 Missing items (on pre-sale test)
9 Environmental requirements are not met

Parts not identified in the circuit diagram:

990000	Unknown/Not applicable
990001	Cabinet or rack (text plate, emblem, grip, rail, graticule, etc.)
990002	Knob (incl. dial knob, cap, etc.)
990003	Probe (only if attached to instrument)
990004	Leads and associated plugs
990005	Holder (valve, transistor, fuse, board, etc.)
990006	Complete unit (p.w. board, h.t. unit, etc.)
990007	Accessory (only those without type number)
990008	Documentation (manual, supplement, etc.)
990009	Foreign object
990099	Miscellaneous

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